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FRED R. LOW, *Editor*

IRVING FELLNER
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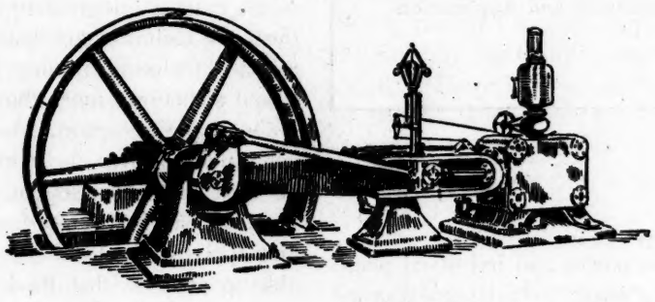


To An Old Corliss

A DOWN EAST subscriber asked for a tribute to the engine that meant so much to industrial America a half-century ago. Many of these are still performing active service in their old age, but, with their makers dead and the places of their birth disorganized, are approaching obsolescence and oblivion. The letter was passed on to Rufus T. Strohm, a former member of the editorial staff of *Power*, and was the inspiration for the following lines from his pen:

F. R. Low

How clearly we recall the day when you were bright and new;
There wasn't anything around that could compare with you.
Beside the slide-valve engine, with its appetite for steam,
You were the incarnation of an economic dream.
Your starting was the signal in the daily strife for bread,
And when you stopped at eventide, the workers went to bed.
We looked upon you with an eye of tenderness and pride
Such as the new-made benedict might cast upon his bride.

Whenever visitors arrived, to peer and poke about,
The engine room was sure to be a station on the route.
The thrusting of your crosshead, and your crank-arm in its sweep,
Recalled the storied giant who awakened from his sleep.
We paused to gaze in wonder at your polished brass and steel,
Your swiftly turning governor, your massive, whirling wheel.
The clucking of your dashpots and the whisper of your gear
Were blended in a melody that charmed the listening ear.

Though swift or slow, the feet of time are never standing still,
For progress is the keynote in the market, mine and mill;
New times demand new methods, and the old must yield the place
When power and efficiency are entered in the race.
Because the wreath of victory is given to the strong,
You lost your honored standing when the turbine came along;
For industry cares not a whit for age or pride or birth,
But gives its ultimate rewards alone to simple worth.

But though the spirit of the age relentlessly ordains
Your exile from the power plant, your memory remains;
For while inexorable change has cast your earthly lot,
The service that you rendered here will never be forgot.
And so we bid farewell to you as to a lifelong friend
Whose term of toil and usefulness has earned a noble end;
And here we write your epitaph, as loyal comrades should:
"For forty years you gave your best, and it was mighty good!"

POWER *Stands for . . .*

1. **Making Power When It Should Be Made**
2. **Buying Power When It Should Be Bought**
3. **Cheaper Power Through Modern Equipment**
4. **Easier Financing of Equipment Purchases**
5. **Better Use of Byproduct Heat and Power**
6. **Operating Methods That Save Money**
7. **Less Waste in Transmission and Application**

Select the Pump to Fit the Job

THERE can be found in power and industrial plants many installations of "misfit" centrifugal pumps. Pumps that, because they are too large or too small for the job, do not operate at their best efficiency. In such installations, although the pump may be well designed and highly efficient, a considerable amount of energy continually goes to waste.

This waste continues throughout the life of the pump and may, during this time, amount to many times the cost of a new unit. When this condition exists it would be profitable to replace the "misfit" pump with one of proper characteristics, or in some instances a second pump operating in parallel might be the proper procedure.

The greatest saving, however, can be made by a little time spent in studying the requirements of the installation and selecting a pump of the proper size to do the job. An article in this number indicates how the pump-performance curves may be used for this purpose.

Real Engineers in the Power Plant

THERE was a time when an understanding of valve setting, indicator diagrams and horsepower computations finished off the complete engineer. Today these accomplishments are but details in a vast fund of knowledge necessary for the efficient operation of a plant. In fact, the field has become so complex, particularly where the engineer must deal with an intricate organization of power services, that a truly professional background of fundamental knowledge is required for real efficiency. Rule of thumb that served well in a simpler and more static age becomes obsolete almost overnight in this era of constant change and development.

One has only to make the rounds of industrial plants, particularly those in the newer and more technical industries, to find a new type of engineer assuming charge of the power function. Like his predecessors, he knows boilers and fuels, engines and turbines, but he adds to this an ability to analyze situations in terms of engineering and economic fundamentals; he knows something about production; he knows how to figure costs, including interest and depreciation; he can evaluate a possible saving in terms of investment and justify his actions and proposals in language the business man can understand. He has the technical knowledge to see the advantages—or the facilities—of the new types of equipment constantly presented for consideration.

Such men are not made by experience alone. Study is an essential ingredient of their success. Many of them are technical graduates. Others, not favored with a formal technical training, have covered the same ground—and sometimes more thoroughly—in private study.

One thing is certain. As the trained engineering mind continually proves its worth in plant operation, it will be more and more sought after until the rule-of-thumb engineer will find himself at best carrying out the orders and applying the ideas of another man. It is unreasonable to suppose that modern industry, forced by competition to rationalize development and production, will leave the power department to carry on in the "good old-fashioned way."

A New Trend Becomes Apparent

FREQUENTLY, plants are encountered that make part of the electricity used and purchase the remainder needed by the establishment they serve. This often permits a much better utilization of the heat in the fuel consumed than could be otherwise obtained.

The opposite set-up, where the industrial plant produces an excess of power and sells it to the utility, is not so often encountered. In fact, instances of such practice are so rare that many engineers are not at all familiar with its possibilities.

However, such interconnections are increasing in number. For instance, in 1926 there were only about twenty-two manufacturing concerns that supplied current to the central stations, while in 1927 there were about sixty. When figures for 1928 are available, it is quite likely that even more of such plants will be noted.

Such layouts have come into use in certain industries because of an unbalance between the steam and electric requirements, either at all times or during parts of the day. These plants, if operated at the point of maximum heat economy, produce more current than can be consumed. As a result, there is available a supply which can be sold to an electric utility company at a figure that spells profit for both parties.

While there are relatively few plants that can benefit from this arrangement, there must still be many that can and have not yet done so. Of course, not all central stations welcome such a hook-up. But the fact that some do, indicates that the practice will spread. Industrial power plants that can produce electricity for sale should look into this matter thoroughly.

Steam for the Process Industries

ALTHOUGH it is generally conceded that coincident power and process steam loads make it possible to generate power at a cost under that at which it can usually be purchased, the impression exists in some quarters that there are few industries in which such favorable conditions obtain. This is far from the case, and the number and importance of such industrial plants is sure to increase with the rapid development of the process and chemical industries.

Today any list of notable process industries must include pulp and paper, rubber products, sugar, food manufacture, dyeing and finishing of textiles, leather, rayon manufacture, roofing materials, composition wall boards, tar products, paints and varnishes, gas, beverages, dairy products, oil refining, chemicals, photographic materials, laundries, soap, and plastics.

The rapid growth of these and other industries, based on chemical engineering, means the increase of processing based on conditions of controlled temperature and pressure furnished by steam. Many chemical reactions demand temperatures of two hundred degrees Fahrenheit and up for most efficient operation. It may therefore be expected that there will be an increased demand for process heat in a variety of industries. This, in turn, will broaden the field for the generation and application of byproduct power.

Don't Forget that the Plant Must Be Operated

MANY modern buildings are so large that the cost of the various services required in them, such as power, heating, ventilating, elevators and others, runs into heavy yearly expenditures. To segregate these service costs requires a well laid out system of meters. The best arrangement can be had only by careful planning of the power feeder and piping system when the building is designed. Just sticking a lot of meters on feeders and steam pipes without any particular reference to what they are going to serve is of little use.

The latter statement may seem like an unnecessary caution, but unfortunately it is justified. One case in point is that of a building where a large sum was expended for electric power meters. When the time came to operate the building, it was found that no consideration had been given to what the feeders, connected to the different meters, served. Elevators and refrigerating equipment were supplied through the same meters, service-pump and air-compressor motors were connected to the same feeders, and other combinations existed. As a result of someone's overlooking the fact that meters are supposed to be useful as well as ornamental, thousands of dollars had to be spent in rearranging the feeder connections and installing additional meters before intelligent records could be obtained.

The responsibility for such a mistake rests with the architects and designing engineers. Apparently, in the design of the power services they overlooked the operation of the building and placed meters on feeders without any consideration as to what use might be made of them. The same old story of the designer overlooking operation. If the operating engineer must go to a lot of trouble to correct the mistakes of the designer engineer, it is not going to increase his respect for the latter.

In buildings there are large opportunities for using meters of various kinds. If these possibilities are to be developed to their fullest extent, intelligent use must be made of the meters installed. The meter manufacturers have a large interest in this field and may well assume at least a part of the responsibility of trying to get their meters installed so that they can be used and encourage their use by the building management and operating engineer. There is no question about the economic value of meters when intelligently used, and the designing engineers and equipment manufacturers may well cooperate toward this end, as they both have large interests at stake.

Checking Performance

IN OPERATING a plant that produces only kilowatt-hours it is a fairly simple matter to maintain a current check on performance. This may be based on coal consumption per kilowatt-hour; on comparison with results attained on actual tests of major equipment or manufacturers' guarantees; or on the basis of a heat balance showing the distribution of losses. Whichever method be employed it becomes necessary to maintain and intelligently apply adequate, but not superfluous, records. Moreover, it is easy to establish some form of performance bogy which can be readily understood and followed by the operating personnel.

When dealing with a plant in which kilowatt-hours is only one of several products, including process steam, compressed air, hydraulic service, etc., the problem becomes more complicated not only because there are several products to consider, but because the user of these products—the production department—may impose conditions beyond the control of the power department. Because of these variable factors it is generally impossible to make any useful comparison between plants, even in the same industry. About the only yardstick in such cases is the cost per thousand pounds of steam produced.

Some industrial establishments reduce their unit power-plant costs to a percentage of the cost of the manufactured product. This affords an opportunity to check against past performance, but it provides no means of spotting losses or opportunities for improvement. However, it is encouraging to see that many of the larger industrial plants are awakening to a realization that adequate instruments, records and men to interpret them are an essential part of the operating procedure. When the practice has become more general there may be available useful and instructive performance records, as is now the case with central stations. There is growing acceptance that such operating practices save money.

NEW B. & A. PLANT

At West Springfield Shops

Is Example of Modern Practice

By F. J. CARTY
Mechanical Engineer
Boston & Albany Railroad

High Spots

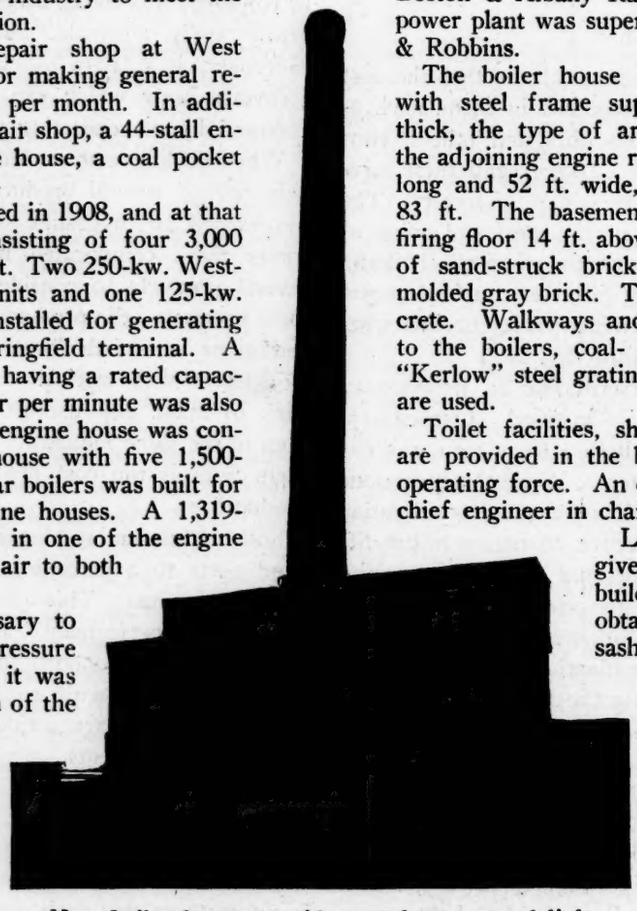
Three 7,280-sq.ft. stoker-fired boilers
Electrically welded outside steam line
Steam-driven, 2,241-cu.ft. air compressor
Automatic combustion control
Ample space and light

TO SUPPLY the many power services required by its locomotive repair shop and terminal at West Springfield, Mass., the Boston & Albany Railroad has replaced two old boiler houses by a new centrally located power station. Thoroughly modern in design and equipment, this plant exemplifies the general tuning up of New England industry to meet the demands of keener competition.

The main locomotive repair shop at West Springfield has a capacity for making general repairs to eighteen locomotives per month. In addition there is a freight-car repair shop, a 44-stall engine house, a 21-stall engine house, a coal pocket and a sand-drying plant.

The shop was last remodeled in 1908, and at that time a new boiler plant consisting of four 3,000 sq.ft. Stirling boilers was built. Two 250-kw. Westinghouse engine-generator units and one 125-kw. engine-generator unit were installed for generating electricity for the West Springfield terminal. A steam-driven air compressor having a rated capacity of 2,052 cu.ft. of free air per minute was also installed. In 1909 a 21-stall engine house was constructed and a new boiler house with five 1,500-sq.ft. horizontal return-tubular boilers was built for supplying steam to the engine houses. A 1,319-cu.ft. air compressor located in one of the engine houses supplied compressed air to both houses.

In 1927 it became necessary to reduce the working steam pressure of the Stirling boilers, and it was then decided to abandon both of the boiler plants and to build a new centrally located power station. This power station was designed by Densmore, LeClear & Robbins, architects and engineers, of Boston, Mass., in collaboration with the mechanical department of the Boston & Albany Railroad. Construction of the power plant was supervised by Densmore, LeClear & Robbins.

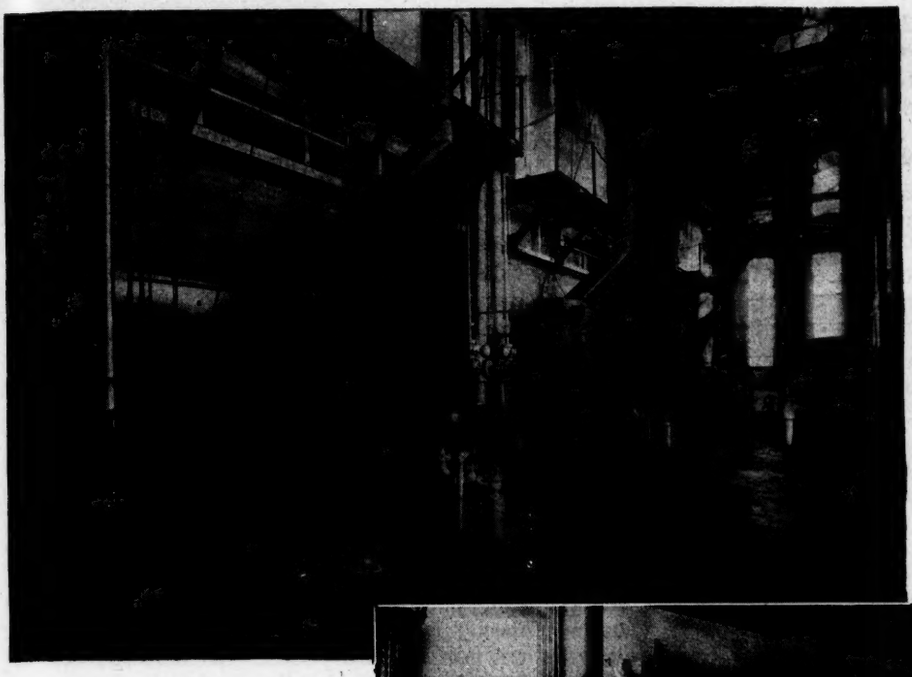


New boiler house provides ample space and light

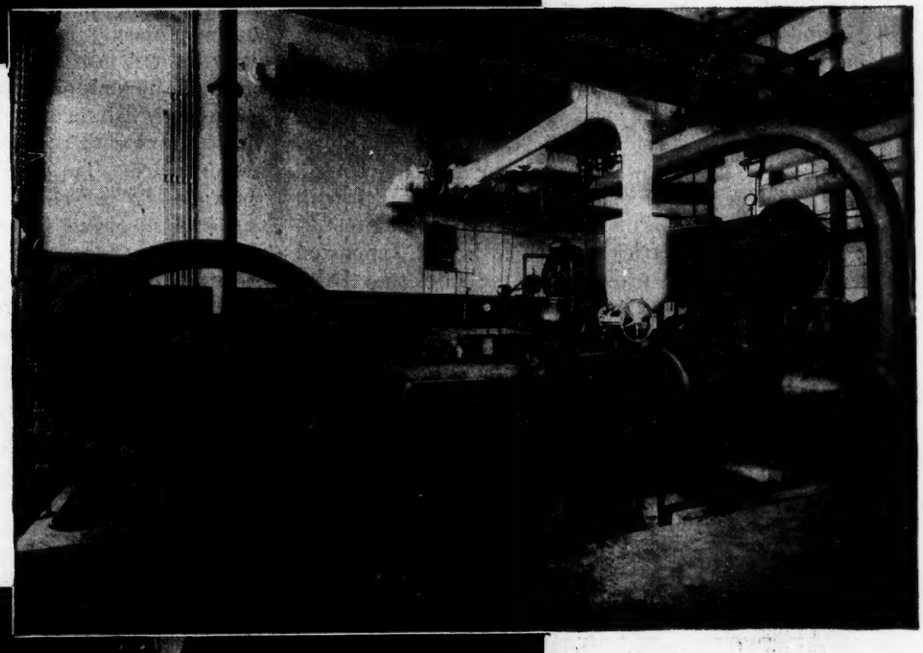
The boiler house is of fireproof construction with steel frame supporting brick walls 12 in. thick, the type of architecture harmonizing with the adjoining engine room. The building is 117 ft. long and 52 ft. wide, with a maximum height of 83 ft. The basement floor is at grade and the firing floor 14 ft. above grade. Exterior walls are of sand-struck brick and the interior walls of molded gray brick. The roof and floors are of concrete. Walkways and stairs give complete access to the boilers, coal- and ash-handling apparatus. "Kerlow" steel grating and double-pipe hand rails are used.

Toilet facilities, shower bath and steel lockers are provided in the basement for the use of the operating force. An office is also provided for the chief engineer in charge of the boiler plant.

Large metal sash windows give ample light throughout the building. Proper ventilation is obtained by the use of pivoted sashes in the windows. Special attention has been given to the lighting fixtures. Twelve-inch flood lights with convex diffusing lenses are used to light the main firing floor. There are six 300-watt ceiling lights in front of the boilers, 18 ft. above the floor, and six 45-deg.



Left—Three stoker-fired cross-drum water-tube boilers, with automatic combustion control, are now installed. There is room for a fourth boiler



Right — This 2,241-cu.ft. per-min. steam-driven compressor furnishes air at 110-lb. pressure to operate pneumatic tools and hoists, elevate sand, etc.

Left—View above boilers, showing 550-ton capacity catenary coal bunker with central compartment for storing 80 tons of ashes

100-watt wall bracket lights, 12 ft. above the floor. Twelve-inch 100-watt flood lights with lamps are also used in the main ceiling of the basement. Special fixtures with 50-watt lamps are used at water columns.

Three 7,280-Sq.Ft. Boilers Installed

Three 7,280-sq.ft., vertically baffled, Heine, size 151 MC-365-20 cross-drum boilers furnish steam at 250 lb. pressure, and the boiler room is large enough to allow of future installation of an additional 7,280-sq.ft. boiler. The highest steam pressure carried on any Boston & Albany locomotive is 240 lb., and a pressure of 250 lb. was decided upon because it was desired to have sufficient pressure to test turbine generators, safety valves, injectors, air pumps, feed-water pumps and boiler appurtenances.

The Bannister system for handling wood shavings in the wood-working mill of the freight-car repair shop has been extended to the boiler room, and wood shavings can be discharged into one or two boilers through furnace feeders of the Bannister positive-feed type.

Conveniently located in the basement is a blowoff tank 3 ft. in diameter and 10 ft. long, made of steel plates, with bumped heads.

The boiler settings have solid firebrick walls 22½ in. thick. All No. 1 firebrick are of "Woodland" brand, full size. All No. 2 firebrick are "Queen's Run" wire-cut brand, ⅛ in. smaller in size than the No. 1 firebrick. Interior walls at the level of the fire are lined with air-cooled Bernitz carborundum blocks to reduce clinkering. Sections of Detrick air-cooled walls, supported on structural steel, are provided at the sides and front of the boiler settings. The rear wall is of solid brick 22½ in. thick, carried on an inclined frame of channel irons and plates. The distance from the bottom of the front boiler header to the floor is 16 ft., giving a large combustion space above the stoker.

Under normal conditions the boilers will be operated at 200 per cent rating, but if desired they can be operated at 250 per cent. Two Vastine furnace-fire observers are provided in each boiler front to enable the operators to observe the fire. Each boiler is equipped with Diamond soot blowers.

Frederick stokers of the 7-retort type, driven by 6.5 hp. type-SD Terry turbines are used. The projected area of each stoker is 129 sq.ft.

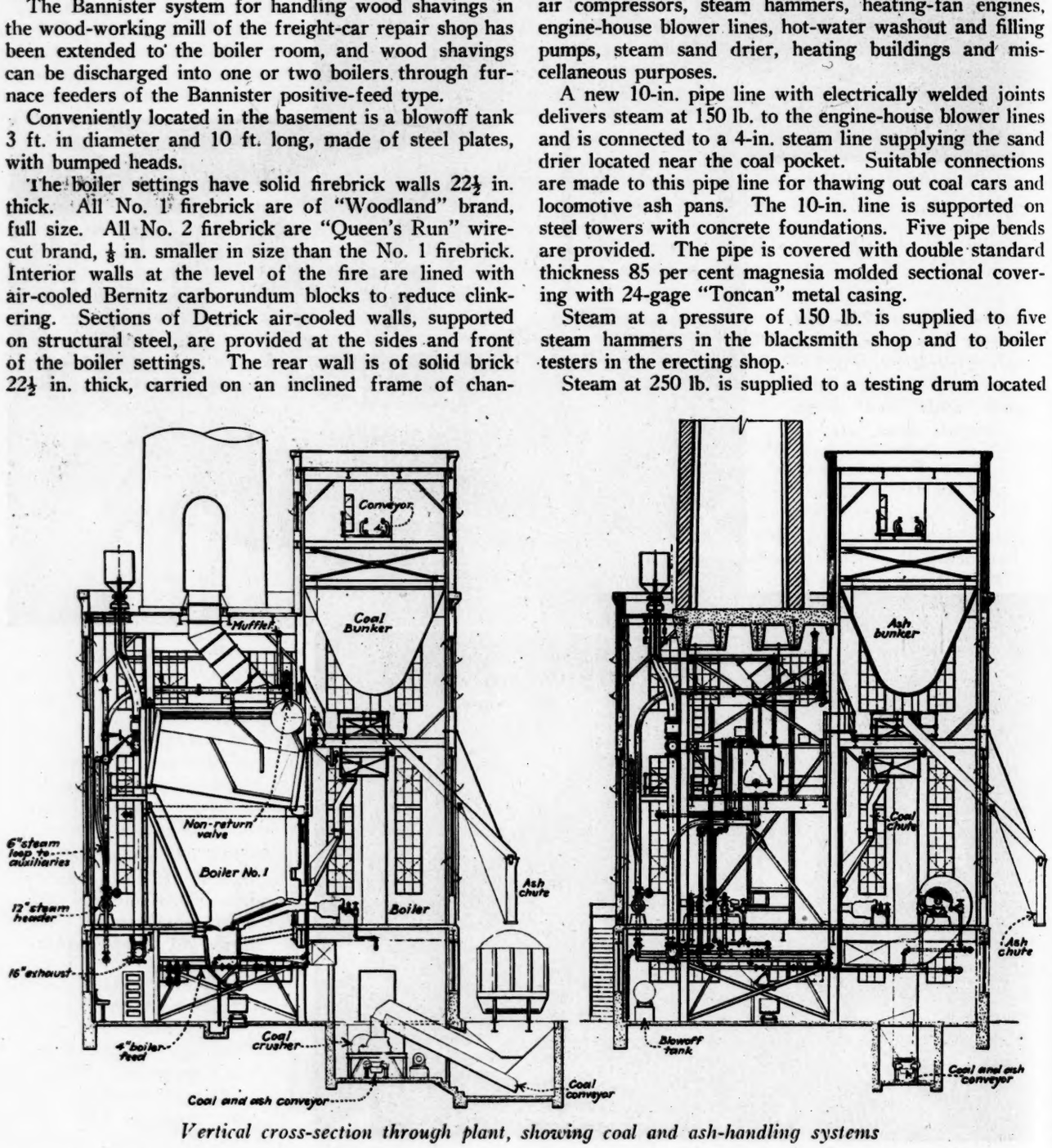
Steam Used for Many Purposes

The boiler plant supplies steam to the entire West Springfield engine terminal. Steam is used for driving air compressors, steam hammers, heating-fan engines, engine-house blower lines, hot-water washout and filling pumps, steam sand drier, heating buildings and miscellaneous purposes.

A new 10-in. pipe line with electrically welded joints delivers steam at 150 lb. to the engine-house blower lines and is connected to a 4-in. steam line supplying the sand drier located near the coal pocket. Suitable connections are made to this pipe line for thawing out coal cars and locomotive ash pans. The 10-in. line is supported on steel towers with concrete foundations. Five pipe bends are provided. The pipe is covered with double standard thickness 85 per cent magnesia molded sectional covering with 24-gage "Toncan" metal casing.

Steam at a pressure of 150 lb. is supplied to five steam hammers in the blacksmith shop and to boiler testers in the erecting shop.

Steam at 250 lb. is supplied to a testing drum located



Vertical cross-section through plant, showing coal and ash-handling systems

in the locomotive shop and to the turbine generator repair shop. This drum is 10 in. in diameter, 8 ft. long, constructed of steel, and has twelve outlets suitable for attachment of such boiler appurtenances as safety valves, water columns, blowoff cock, etc.

Compressed Air Used for Pneumatic Tools, Hoists and Air-Brake Testing

Two 250-kw. Westinghouse engine-generator sets have been retired from service and a new 2,241-cu.ft. Chicago Pneumatic Tool Company type OCSC air compressor has been installed in the same space. The 2,052-cu.ft. compressor, installed in 1908, has been retained as an auxiliary machine, but the 1,319-cu.ft. compressor, formerly located in one of the engine houses, has been shut down.

Air is delivered at a pressure of 110 lb. After passing through a water-cooled aftercooler it enters the main reservoir, from which it is distributed to the shop and engine houses for use in pneumatic tools, hoists, elevating sand, etc. The compressed-air line to the engine houses is 5 in. in diameter, supported on steel towers, which also support a 10-in. steam pipe. Compressed air is also furnished to the air-brake testing system in the westbound freight yard. Approximately 17 freight trains per 24 hours are dispatched from this yard and the air brakes are tested prior to departure of the trains.

Feed-Water Heater and Pumps

Two Warren 4-stage centrifugal boiler-feed pumps, type 3-4H-10, each having a rated capacity of 230 gal. per min., are located at the middle of the boiler room, under the feed-water heater platform. They are driven by 45-hp. type-E Terry turbines.

Extra-strong 4-in. butt-welded wrought-iron pipe is used for the boiler feed-water lines. A type-E Stets regulator controls the feed water to each boiler.

A Cochrane feed-water heater on a platform at the middle of the boiler room between boilers 2 and 3, receives the hot-water returns, together with exhaust steam from the air compressors, 125-kw. engine-generator unit, boiler feed pump, stoker and forced-draft fan turbines. The average temperature of the boiler-feed water is 202 degrees.

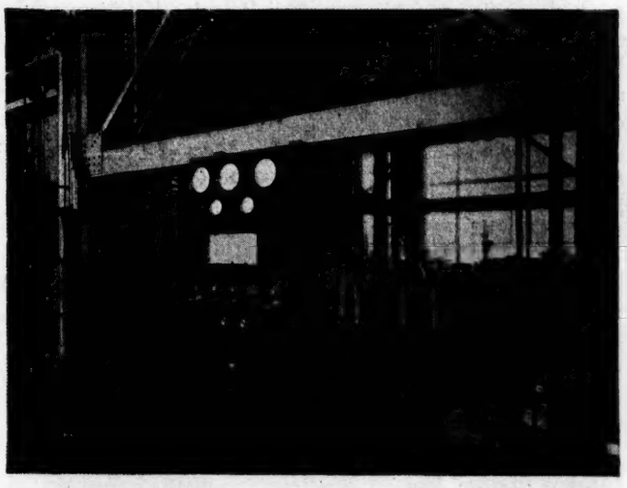
Two sources of water are available at West Springfield, and upon analysis it was found that one source of supply is much more suitable for boiler feed. The piping systems have been arranged so that in case of an interruption in the supply of water from either source, the other water can be used in the boilers.

Coal and Ash Handing Equipment

On the roof of the boiler house is a smoke flue of the Connery expansion type with joints electrically welded. The stack is of the radial brick type, 10 ft. in diameter and 175 ft. high, supported on the lower roof of the boiler house, the top of the stack being approximately 219 ft. above the firing floor.

Suspended from steel trusses over the firing floor, the coal bunker has the usual catenary form. It is 95 ft. long, 20 ft. wide and 15 ft. deep, and is lined with bitumastic enamel to prevent corrosion. A compartment 19 ft. long is provided at the central part of the coal bunker for storage of ashes. This compartment is capable of holding 80 tons of ashes, or about two carloads. It is lined with 2 in. of Gunite to prevent abrasion and corrosion of the steel plates. The coal bunker has a capacity of 550 tons. Richardson type-J-55 individual automatic weighing scales are installed under it, in front of each boiler. After being weighed, the coal passes through 12-in. down spouts into "Non-Seg" spreaders which deliver it to the stoker retorts.

A concrete track hopper of the usual type is provided under the coal track near the wall of the boiler house. Coal is discharged from hopper cars into the track hopper and is then carried by a short inclined belt to a motor-driven crusher. From the crusher the coal falls into the horizontal line of conveyor buckets. Coal and ash-handling equipment is of the Jeffrey Manufacturing Company "run around" type and has a capacity of 30 tons an hour.



Master controller of automatic combustion control system which adjusts fuel and air input to boilers when steam pressure starts to rise or fall

The ash hoppers are of the Beaumont Manufacturing Company type, built of steel and lined with shale brick. Ashes are discharged from the hoppers into steel dump cars which run on narrow-gage track and discharge through a grating into a concrete hopper above the horizontal line of conveyor buckets. The coal-handling apparatus is used to elevate ashes to the overhead ash storage bunker. Ashes are drawn periodically from the bunker through an inclined chute discharging into a cinder car standing on the coal track outside the boiler house.

Forced draft is supplied by two Sturtevant turbovane, size-95 fans driven by 36-hp. type-F Terry steam turbines.

Eight-inch non-return valves are connected to the steam outlet flanges on the boiler drums. The steam passes through pipe bends of 6-ft. radius into vertical boiler leads connected with the 12-in. main steam header behind the boilers and 2 ft. 9 in. above the floor. Eight-inch gate valves are installed between the non-return valves and the main header.

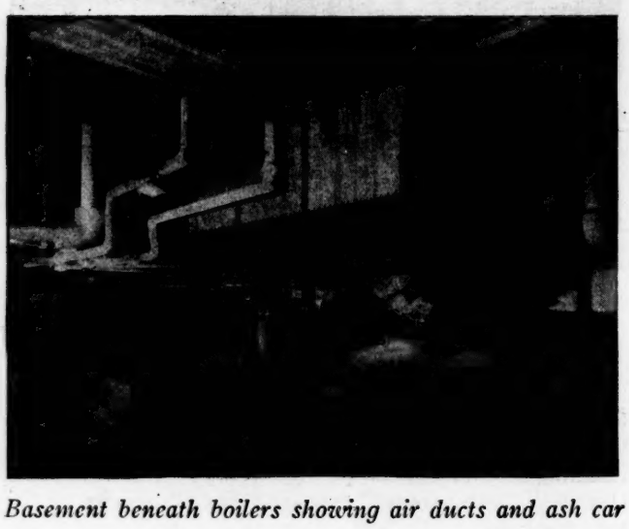
All important piping has been sectionalized and is arranged in a loop form so that any one of the boilers can be shut down without interfering with delivery of steam from the other boilers.

Standard lap-welded open-hearth steel pipe, with standard 250-lb. steel flanged fittings, is used in the high-pressure piping systems for pipe of 2-in. size and larger. Van Stone joints are used for pipe 4-in. in diameter and over, except for flanges on the outlets at

the main steam header, which are of forged steel electrically welded to the pipe. High-pressure steam piping is covered with 85 per cent magnesia molded sectional covering. Pipe fittings on covered piping are covered with plastic magnesia with canvas jacket.

An 8-in. pipe extends from the main steam header to the new 2,241-cu.ft. air compressor which operates at a steam pressure of 240 lb. Steam at this pressure is also supplied to the steel drum used for testing locomotive boiler appurtenances. Another 8-in. pipe runs from the main steam header to a Ruggles-Klingeman reducing valve, which reduces the pressure to 150 lb. Leaving the reducing valve, the steam passes through a 10-in. pipe connected with the piping systems of the engine houses.

A 4-in. connection at the end of the engine-house line supplies steam to an Ogle steam sand drier near the coal



Basement beneath boilers showing air ducts and ash car

pocket. Suitable connections are provided for thawing out locomotive ash pans and coal in cars at the coal pocket. An 8-in. connection at the main header delivers steam to a Ruggles-Klingeman reducing valve supplying steam at 150 lb. to the present 2,052-cu.ft. air compressor and 125-kw. engine generator.

Pratt & Cady cast-steel valves suitable for 250-lb. pressure are used. The bronze valves were manufactured by the Chapman Valve Company.

For purposes of identification the various piping systems are painted different colors in accordance with a standard color scheme.

Each boiler is equipped with a 12-in. Ashton steam gage and a Bailey multi-position gage, indicating windbox pressure, furnace draft and draft in uptake. Bailey boiler meters indicate and record steam flow, air pressure in windbox and flue-gas temperature.

In the chief engineer's office is a recording steam pressure gage and two Bailey fluid meters, one recording the steam furnished to the shop and the other that supplied to the engine houses.

Automatic Combustion Control

The Smoot system of automatic combustion control is installed. The master controller is located at the middle of the firing floor between boilers 2 and 3. A regulator is attached to each uptake damper, each windbox damper, and in the steam lines to the forced-draft fans and stoker turbines. The dampers are operated by oil pressure and the regulator pilot valves by compressed air. Variations in the steam pressure actuate the controller, increasing the fuel and air input to the boilers when the steam pressure falls, and decreasing the supply when the steam pressure increases. The fuel-air ratio is constant and the automatic combustion control aids in the efficient production of steam.

Electrical Supply

Electric current is purchased from the Turners Falls Power & Electric Company and is supplied to the railroad at 13,800 volts. The voltage is stepped down to 440 volts for use in the shop and engine houses. The 125-kw. Westinghouse engine-generator set has been retained for emergency power to turntable motors, traveling cranes and to a limited number of machine tools.

Two panels have been added to the switchboard, which is in the engine room and the entire switchboard has been renovated.

Preheating Castings for Welding

THE following comments on preheating castings for soldering have just been released by the Linde Air Products Company:

The preheating facilities necessary in any welding shop or department naturally depend upon the run of work handled. Cast-iron welding forms perhaps a major part of the average welding shop's daily work, and it pays the shop manager to give close study to preheating problems encountered in the various types of castings. Small pieces can be preheated by the oxyacetylene blowpipe and welded without much difficulty. This method, however, is impracticable for larger pieces. A blacksmith's forge is sometimes used for certain pieces, but with this there is the possibility of overheating or burning the metal on one side, if constant care is not exercised.

The most practical and most economical method of preheating large pieces, particularly where the entire casting is to be heated, is the use of the temporary firebrick furnace. This is built of loose firebrick laid without mortar. It is quickly constructed and can be built to any size desired. Asbestos paper, having holes for draft, if necessary, may form the top of the furnace. The spacing of the bricks around the base of the furnace should be such as to assure sufficient draft to raise the piece to the proper temperature.

In order to keep a desired temperature, the fire must be regulated occasionally while the welding progresses. This is done by opening or closing the draft holes, rearranging the asbestos paper covering, moving hot coals from one place to another, or replenishing the fire whenever necessary. This important detail is usually performed by a helper. When the casting has reached an ever necessary. This important detail is usually perpaper cover just large enough to uncover the weld area, and welding is done through this hole.

After the weld is completed it is just as important to secure proper cooling. The entire casting or piece should be covered with fresh charcoal and brought up to an even heat. With the asbestos covering intact, the finished work should be allowed to cool and contract evenly in the dying fire.

Preheating and annealing of cast iron is on essential part of welding technique. It is not a difficult feature for the methods of constructing the preheating furnace and governing the preheating temperature are easily understood.

By giving consideration to those factors that affect wire-rope life, the engineer can extend their period of service and thereby reduce the cost of replacements in elevator operation

Twenty Causes of Reduced Wire-Rope Life

Full-wrap direct-traction elevator machine

BY F. A. ANNETT
Associate Editor

ELEVATOR rope life depends upon a multitude of factors and may extend over periods ranging from a few months to fifteen or twenty years. Although it is quite general practice to express life of wire ropes in terms of the time they have been in service, this method is not so accurate a measure as car mileage. In many of the better operated buildings recorders are installed on the elevators and a record kept of car mileage, and rope life is based on these records. Car mileage is not, however, always a measure of rope mileage, since on two-to-one roped traction machines the rope speed is twice the car speed. With such installations it is necessary to multiply the car mileage by two to obtain the hoisting-rope mileage, which is the measure of the service rendered by these ropes.

There are many ways of roping-up elevator machines, and they all have an influence on rope life. On the full-wrap type traction machine the ropes make the two half-wraps over the traction sheave and one half-wrap around the secondary sheave. That is, the ropes make three 180-deg. bends all in the same direction. On the V-grooved type traction machine the ropes make only one 180-deg. bend, but they are subjected to a wedging action in the grooves. The single bend in the V-grooved sheave is apparently not any more severe on hoisting ropes than the three bends that obtain with U-grooved sheaves on the full-wrap type of machine.

On the two-to-one roped traction machine the ropes travel twice as fast as the car, consequently, as measured in car miles, the ropes have a much shorter life than for the one-to-one roped machines, where the car and ropes have the same speed. If the life of the ropes is measured in rope miles, then the two-to-one roped machine will generally show a greater mileage than the one-to-one type machine.

On the two-to-one roped machine there is a reverse bend in the ropes around the sheave in the cars crosshead and another around the sheave in the counterweight crosshead. Contrary to general belief these are not in the true sense reverse bends. The sections of the ropes that pass around the crosshead sheaves do not reach the traction sheave and are therefore not subjected to reserve bending, although they bend in an opposite direction to sections that run over the traction and secondary sheaves. The common belief that short life of the ropes on two-to-one traction machines is caused by reverse bends in the ropes has no foundation.

The loading on the hoisting ropes of a two-to-one traction machine is only about one-half that for the one-to-one machine, therefore it is to be expected that in rope miles the life of the former would be longer than the latter, which is generally the case. For the one-to-one traction machine, the car mileage for a set

The Twenty Causes

1. **Method of roping up the machine.**
2. **Number of bends in the ropes and their direction.**
3. **Material used in the ropes and the type of construction.**
4. **Speed of the ropes.**
5. **Relative hardness of the material in the ropes and the sheaves.**
6. **Size of the sheaves and drums.**
7. **Condition of the sheaves' grooves.**
8. **Load distribution of the ropes.**
9. **How the ropes lead on and off the sheaves and drum.**
10. **Care given when installed.**
11. **Care after installation.**
12. **Height of car rise.**
13. **Number of stops per car mile.**
14. **Car operating schedule.**
15. **Number of false stops.**
16. **Efficiency of the operator.**
17. **Brake adjustment**
18. **Lubrication and atmospheric condition.**
19. **Rate at which the car is accelerated and retarded.**
20. **Rules used by and the judgment of those who condemn the ropes.**

of hoisting ropes is in general considerably greater than for the two-to-one traction machine. Of course, high car mileage is what the owner of the elevators and the plant engineer are interested in obtaining from a set of ropes.

On basement-type drum machines the counterweight ropes come off the top of the drum and make a reverse bend around a vibrating sheave *A*, Fig. 1, to go up the hoistway. On some of the installations in low-ceilinged basements it is necessary to locate this sheave close to the drum so that the ropes bend almost 90 deg. Such a reverse bend is conducive to short rope life and should be avoided where possible.

Wire ropes wear out from two causes: (1) a reduction in area produced by wearing of the individual wires and (2) breakage of the wires. In elevator service the latter is the cause for condemning practically all elevator ropes. From this the conclusion might be drawn that in general there has been a tendency to use elevator ropes that were too stiff for the service. In present-day practice the tendency is toward the more flexible 6x37 and 8x19 instead of the 6x19 construction, which was used at one time almost exclusively. The more flexible constructions are in general showing a longer life.

All elevator ropes are constructed with a hemp center. If the hemp center happens to be undersized or does not possess sufficient density, after the ropes are put into service the strands may work together and cause a large friction component between them as the ropes bend around the sheaves. This may set up stresses in the surface wires of the strands that will cause them to fail after a short service period. The hemp center in the rope should be of the proper diameter and of sufficient rigidity to support the strands in their correct relation. It should also be well lubricated.

It is not recommended to store ropes for a long time before using them, as there is danger of the lubricant drying out and moisture working into the ropes. In one case in mind, where rope had been stored for a long time, only a few months' service was obtained before they had to be renewed.

The speed of the ropes probably has little direct effect on their life when measured in miles of travel, except as it has a bearing on other factors. Rope speed may lead to wrong conclusions if the rope life is expressed in time. On slow-speed elevators the ropes may have a life of eight or ten years or longer. On a high-speed elevator the same ropes may last two years. In point of years' use this does not look very good for the high-speed ropes. If the rope mileage of the two machines is compared, it will probably be found that the mileage for the high-speed ropes greatly exceeds that for the slow-speed. In other words, the high-speed ropes are giving longer service. The difficult part of this comparison is to find slow-speed machines on which accurate mileage records are kept.

The material in the sheaves should be harder than the ropes, or the sheave grooves will wear too fast. This is a problem of design and one that the user has little control over, except to see that the sheave grooves are in good condition when a new set of ropes is installed.

It is recommended that the sheave or drum diameter be as large as possible, consistent with other conditions. It is preferred not to have traction sheaves less than 28 in. in diameter or about 40 rope diameters. Larger diameters than this will be favorable to rope life. When they bend around the sheaves or drum, the stress is normally reduced on the side of the ropes in the grooves and increased on the outside. The smaller the sheave the more severe this action becomes on the ropes, with a consequent shortening of their life.

The conditions of the sheave grooves have a marked effect on the life of hoisting ropes, particularly on traction machines. If the U-shaped grooves are worn to fit old ropes, a new set will wedge into the grooves. This wedging action tends to distort the ropes and cause fatigue and breakage of the wires. Since the grooves are generally not all worn to the same tread diameter, some of the ropes must travel faster than others. To accommodate this difference in rate of travel some of the ropes must slip. If they wedge into the grooves, the difference in loading of the ropes before slippage occurs will be increased and may cause excessive stresses to de-

Fig. 1 (Left) — Drum-type elevator machine

When the machine is installed in the basement, the counterweight ropes come off the drum and lead up the hoistway around sheave *A*. The bend around the sheave is in a reverse direction to the way the ropes are wound on the drum. The reverse bend made around the sheave tends to reduce the life of the ropes, particularly if the sheave is close to the drum.

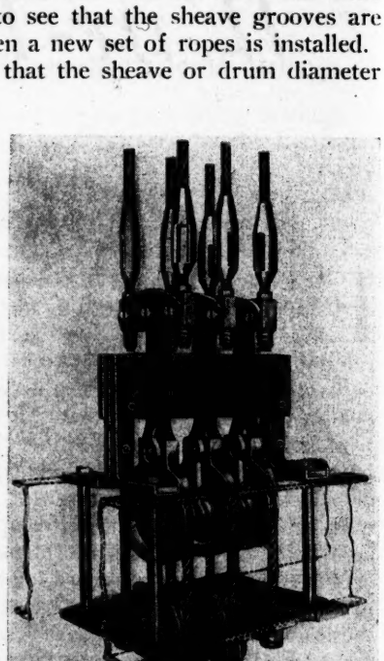


Fig. 2 (Right)—Traction machine hoisting-rope equalizer installed in the car's crosshead

Each pair of ropes connect to the ends of an equalizing bar. These bars connect to sheaves that in turn are connected to a plate, under the crosshead, by an equalizing cable. This arrangement equalizes the ropes' loading.

velop in some of them. As the surface wires must resist the forces that cause slippage, they may be stressed until actual breakage occurs.

When the hoisting ropes are to be changed on a machine, the grooves in the sheaves should be checked, and if found undersize or of unequal tread diameter, they should be put in proper condition. If more attention were given to this feature of elevator operation, the life of hoisting ropes would be greatly increased in many cases.

Equal tension should be maintained in the hoisting ropes. This is difficult, since one rope may have a tendency to stretch more than another or the grooves in the sheave may not have exactly the same tread diameter. It is becoming quite general practice to use equalizers on the hoisting ropes of traction machines. Fig. 2 shows an Evans equalizer installed on a car's crosshead. Each pair of ropes connect to the ends of an equalizing bar. These bars connect to sheaves attached by an equalizing rope to a plate under the car's crosshead. This arrangement allows the load to equalize between the different cables, and it also tends to compensate for any difference there may be in the tread diameter of the grooves in the traction sheaves. If the cables tend to stretch unequally, this can be easily detected on the equalizer and their length adjusted before they become unequally loaded. Experience has shown that unequal loading of ropes due to excessive stretch of some of them has been the cause of short rope life in more cases than is generally supposed.

It is necessary that the ropes lead off the sheave without rubbing one side of the grooves. This applies more particularly to the sheaves on drum-type machines. One of the bearings worn on an overhead sheave would throw it out of line. If the shaft on which the vibrating sheave travels is not kept well lubricated, the sheave will lag on the shaft and throw the ropes out of line with the grooves as they come off the drum and will cause unnecessary wear on them.

Care Used When Installing the Ropes

The care exercised when installing the ropes may have a marked effect on their life. This subject is such a large one that it will be treated in a separate article.

The height of the car rise, whether the car is used for local or express service, the schedule on which it operates and the kind of operator in it, all have an effect on the life of the ropes. The ropes on a high-rise car will have a longer life in car miles than those on a low-rise car. This is to be expected, since the high-rise car makes fewer trips per car mile, and this means less bending of the cables around the sheaves and less wear on them.

In the Union Central Life Insurance Building, Cincinnati, the high-rise cars travel about 400 ft. and the low-rise cars about 240 ft. Up to Nov. 1, 1927, the four high-rise cars had used 15 sets of hoisting ropes. These ropes had an average life of about three years and an average mileage of 25,567. The eight low-rise cars used 24 sets of ropes which had an average life of about 3½ years, but the average car mileage per set of ropes was only 15,425 miles.

In this building M. W. McIntyre, building manager, and C. B. Garrison, chief engineer, have kept comprehensive records of elevator-rope life from the time the elevators were started in 1913.

The schedule on which the car operates affects rope life. When the car is started and stopped the ropes are stressed above normal owing to the effect of acceleration and retardation. When a car is retarded in the down motion at the rate of about 8 ft. per sec. per sec., the load on the ropes will be increased to double normal. The change in loading caused by starting and stopping the car tends to fatigue the wires in the ropes and causes them to break. This is one reason why the ropes on a car in local service will have a shorter life than one in express service, even when both have the same rise.

Inching the car to make a landing also affects the life of the ropes. This is caused in a number of ways. One is the result of the increased loading of the rope when the car is started and stopped; another is the increased bending of the ropes. A car on the down trip is stopped below a floor. To bring it level with the floor the machine is reversed and a section of the ropes wound back on the drum. This section has been bent twice, once when the car went below the floor and once to bring it level with the floor. A third bend is put into this section of the ropes when the car again starts on its down trip. From this it is seen that a section of the ropes at the sheave corresponding to the position of the car at the floor is bent three times, owing to one false stop. This section would have been bent only once if the car had been stopped level with the floor on the first trial. The sections of the ropes that are wound on and off the sheave owing to jockeying the car at floors will generally be where the ropes fail first. The operator in the car is therefore a factor in the life of the ropes.

Effects of Brake Adjustment

If the brake is adjusted to stop the car too quickly, the ropes are subjected to unnecessary stresses. On the other hand, if the brake allows the car to slide, there will be an increased number of false stops with increased bending of the ropes, as previously explained. A poorly adjusted brake adversely affects the ropes.

In a damp atmosphere or where there are acid fumes in the air, the ropes may require lubrication to prevent them from rusting or corroding. When made they are well lubricated, and under normal conditions this lubrication may be sufficient to last for their life. When they bend around the sheaves the strands have a certain movement in relation to each other, as also do the wires in the strands. Unless the ropes are properly lubricated the wires will tend to wear each other, and the increased stresses may cause breakage of the wires.

Another factor in the life of ropes is the judgment of the man who condemns them. There is no method by which the condition of a set of ropes may be exactly appraised. A general rule is to condemn the ropes when six contiguous wires are broken in one strand. The conditions under which the ropes operate must also be taken into consideration. One inspector may order the ropes changed when another would allow them to run awhile longer. On account of the many factors that affect a rope's condition and that cannot be evaluated, there is good reason for a difference of opinion as to when ropes should be condemned.

Much has been said on the reserve strength of ropes. The high breaking strength developed by ropes that have been condemned has led some competent rope engineers to feel that there is a tendency to condemn ropes too soon. Even with the present liberal attitude on the side of safety there have been rope failures that are difficult to account for. Until some means is available whereby the reserve strength of ropes can be determined while they are in service, it will be well to continue to error on the side of safety.

Electric Current Generation

From Purchased Steam

By L. E. LOVETT
Consulting Engineer, New York City

An economic study of the effect of building size on the possible savings to be made by generation of power from steam purchased for process and heating. The final results obtained will necessarily vary with the rate structure for steam and electricity and with other conditions. But the author shows a method of attacking the problem and works out a typical example.

RECENT events have aroused renewed interest in the relative economy of purchased and privately generated current. Private generation of steam power does not necessarily require a boiler plant. In urban districts, where central steam is available, the generation of byproduct power in the plant of the steam customer presents interesting possibilities. The method of attacking such problems is illustrated by a study the author has made for a loft building in New York City.

The building under consideration, a structure of sixteen stories, having a total floor area of 140,000 sq.ft. and containing approximately 1,540,000 cu.ft., is devoted almost entirely to the millinery trade. It is representative of a large number of similar buildings in the particular district in which it is situated.

Saturated steam for heating and process work is provided from a metered line of the local central district steam company at a pressure 125 lb. Reducing valves are used to give steam at 75 lb. for process work, and about 2 lb. for heating the building. Hot water is supplied by passing the heating returns through a heat exchanger on a branch of the incoming cold-water line. All returns are wasted to the sewer.

Direct current at 125-250 volts is provided by the public utility and is at present metered on a wholesale rate. The service of a supervision company is utilized for metering current furnished to tenants. This company handles all meter installation, readings, testing and adjustments for a reasonable percentage of the monthly bills, thus releasing the owner from all bother in connection with the service.

Steam is purchased on what is known as "Power Service Classification No. 2," covering installations having a minimum demand of 250,000 kals (pounds) of steam per month, based on the lowest four month's average consumption.

Billing for steam used is made in accordance with the following schedule:

The first 500,000 kals of minimum of demand	$0.90	per 1,000 kals consumed in each monthly period.
Balance of minimum of demand	0.50	
For all excess over minimum of demand:		
The first 3,000,000 kals at	$0.75	per 1,000 kals consumed in each monthly period.
All over 3,000,000 kals at	0.55	

An additional coal charge of approximately $0.15 per 1,000 kals is at present assessed for all steam used.

A general steam-service rate known as "Service Classification No. 1" is also available, but is applicable primarily to office and loft buildings having a total content of less than 1,000,000 cu.ft. The minimum monthly demand under this rate is 10,000 kals and steam is billed in accordance with the following schedule:

First 50,000 kals per month, $1.85 per 1,000 kals.
Next 50,000 kals per month, $1.25 per 1,000 kals.
Next 100,000 kals per month, $1.10 per 1,000 kals.
Next 200,000 kals per month, $1.00 per 1,000 kals.
Next 200,000 kals per month, $0.90 per 1,000 kals.
Next 400,000 kals per month, $0.80 per 1,000 kals.

Electric current is purchased on what is known as "Service Classification No. 2," wholesale for light, heat, power and other purposes.

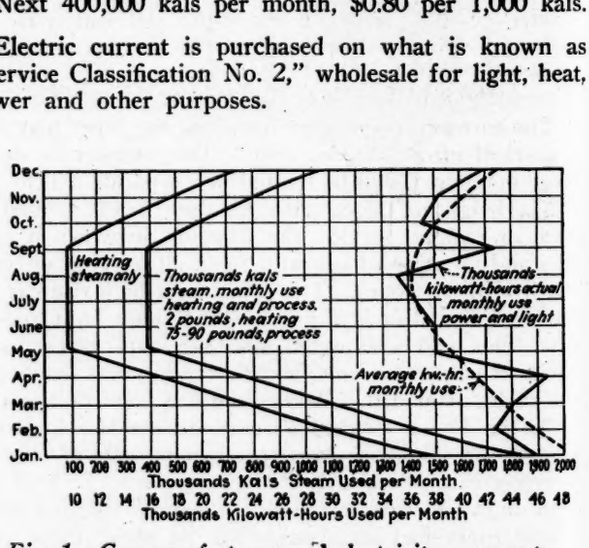

Dec.
Nov.
Oct.
Sept.
Aug.
July
June
May
Apr.
Mar.
Feb.
Jan.
Heating steam only
Thousands kals steam, monthly use heating and process, 2 pounds, heating 75-90 pounds, process
Thousands kilowatt-hours actual monthly use power and light
Average kw.-hr. monthly use
100 200 300 400 500 600 700 800 900 1000 1100 1200 1300 1400 1500 1600 1700 1800 1900 2000
Thousands Kals Steam Used per Month
10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48
Thousands Kilowatt-Hours Used per Month

Fig. 1—Curves of steam and electricity consumption for building investigated (typical office and loft building of millinery trade, New York City. Total floor area 140,000 sq.ft. Volume 1,540,000 cu.ft.)

Billing for electric current used is made as follows:

First 75,000 kw.-hr. consumed in each yearly period, 5c. per kw.-hr.

Next 100,000 kw.-hr. consumed in each yearly period, 4c. per kw.-hr.

Next 150,000 kw.-hr. consumed in each yearly period, 3c. per kw.-hr.

Next 775,000 kw.-hr. consumed in each yearly period, 2½c. per kw.-hr.

Excess over 1,100,000 kw.-hr. consumed in each yearly period, 2c. per kw.-hr.

An additional coal charge of approximately $0.002 per kilowatt-hour is assessed for all power used.

The seasonal variation in the heating and process steam and electric power loads is shown by the curves in Fig. 1. The heating load is variable, reaching its highest demand about January and its lowest demand between May and October. Process steam demand is fairly constant, although subject to some periodic fluctuations due to conditions in the trade.

Electric current demand is subject to seasonal variations of approximately 20 per cent in this particular instance, although the average fluctuation of a number of buildings of this class is somewhat less than 10 per cent.

In Fig. 2 are shown three curves indicating the yearly steam consumption of office and loft buildings of various sizes devoted to the millinery trade and the corresponding approximate total cost of steam per year.

It is interesting to note in this connection that steam for buildings having a content of between 800,000 and 900,000 cu.ft. will cost practically the same amount on either general-service classification rate No. 1 or power-service classification rate No. 2. Buildings of this class below 900,000 cu.ft. contents would in general be placed on general-service classification rate No. 1.

Fig. 3 shows the yearly consumption and corresponding costs of electric current of loft and office buildings of various sizes devoted to this trade.

For the purpose of determining the proper size of a steam-electric generating unit required for the isolated plant, it is necessary to determine the maximum demand of the electrical load. This is accomplished by installing a graphic wattmeter for a period covering the conditions of operations when the demand is greatest, preferably during the winter months. Fig. 4 indicates the size and installed cost of a uniflow-engine unit required for various sizes of office and loft buildings in the millinery trade. For the building selected for the study, having a floor area of 140,000 sq.ft., a 200-kw. three-wire direct-current unit would be necessary.

A uniflow steam engine for driving a generator of this capacity has an over-all steam rate of approximately 45 lb. of steam per kilowatt-hour, and the rate is fairly

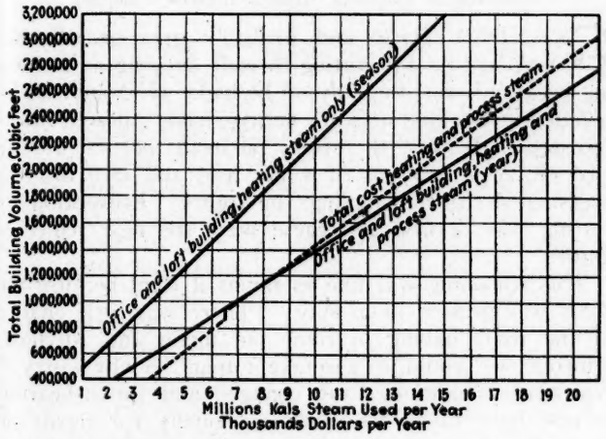


Fig. 2—Steam consumption and costs (dotted line) for average loft building, millinery trade. Purchased steam 125 lb. saturated

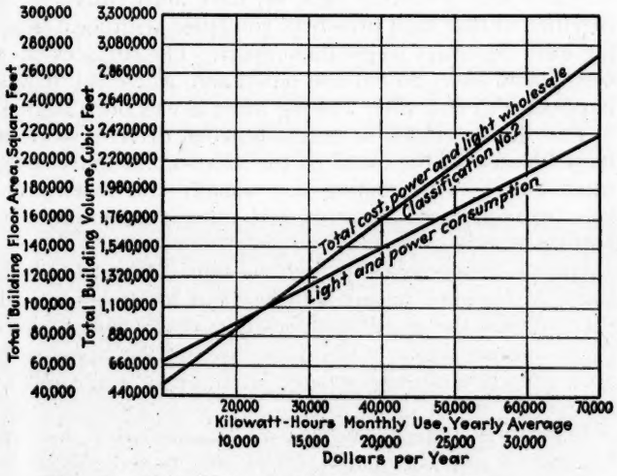


Fig. 3—Electric current consumption and cost, average loft building millinery trades. Purchased power classification No. 2

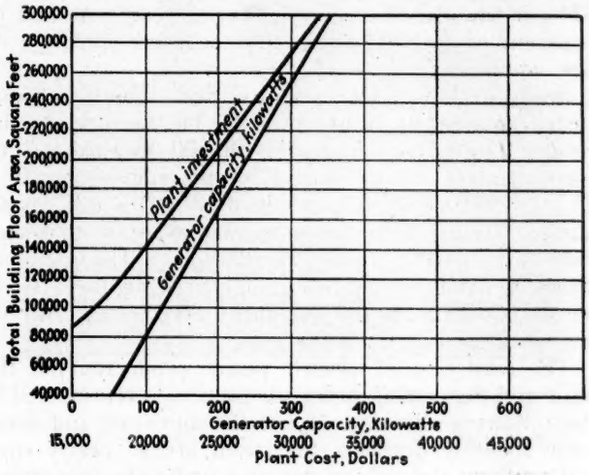


Fig. 4—Generator capacities and plant investment. Based on one uniflow steam engine generator

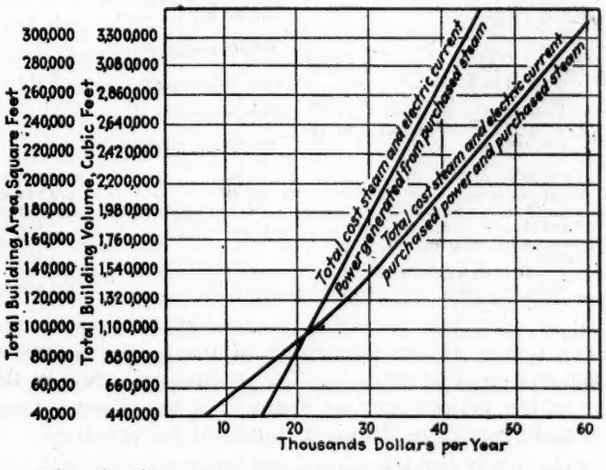


Fig. 5—Comparison of total yearly costs steam and electric current with purchased current and current generated locally from purchased steam

constant over a rather wide range. This rate is based on saturated steam at 115 lb. initial pressure and 2 lb. back pressure. It should be understood that much better economy may be secured from steam at higher pressures, but that this study is based entirely on the problem of electric generation from purchased steam.

The cost of this unit completely installed in the New York district will be approximately $100 per kilowatt, including necessary changes in existing building.

For night operation central-station electric service should be used and arranged for breakdown service for a total demand of 50 kw. The charge for this service is $24 per kw. per year, or $1,200 per year. A total investment of $20,000 would thus be represented by the new equipment.

Study of Fig. 1 shows an average monthly process steam requirement of 300,000 kal. The average monthly electric power consumption is 40,500 kw.-hr. and the corresponding steam demand for the engine 40,500 × 45 = 1,800,000 kals, approximately. This exceeds the highest demand for exhaust heating steam, so that some exhaust would be wasted at all times. The minimum steam demand (June, July, August, September) would be 300,000 kals for process plus 1,800,000 kals for the engine, a total of 2,100,000 kals.

The total cost of electric power production on this basis and the cost of steam for process is represented by the following elements. Since the minimum and maximum monthly demands for steam are so nearly equal and uniform throughout the year under the new conditions of generated electric current, practically no steam will be required beyond the minimum demand and it may therefore be purchased at the lowest rate.

(A) Steam for generation	1,800,000 kals per month		
Steam for process	300,000 kals per month		
Total	2,100,000 kals per month		
Cost first 500,000 kals of minimum demand @ $0.90	$450.00 per month		
Balance of minimum of demand 1,600,000 kals @ $0.50	800.00 per month		
Coal charge, 2,100,000 kals at $0.15 per 1,000 kals	315.00 per month		
Total monthly cost	$1,565.00	Yearly Cost	
Total yearly cost	18,780.00	$18,780.00	
(B) Central station breakdown service		1,200.00	
(C) Fixed charges on $20,000 investment @ 12 per cent		2,400.00	
(D) Repairs and supplies		2,400.00	
(E) Labor		2,500.00	
Total net yearly cost (except depreciation)		$27,280.00	

It is advisable to utilize the central station breakdown service to the full extent of the yearly minimum fixed charge of $1,200. The use of this power is charged for at the general rate as follows; it may be used up for night service or during a shutdown for repair.

First 1,000 kw.-hr. per month, $0.07 per kw.-hr.
Next 400 kw.-hr. per month, $0.06 per kw.-hr.
Next 800 kw.-hr. per month, $0.05 per kw.-hr.
Next 1,100 kw.-hr. per month, $0.045 per kw.-hr.
All over 3,300 kw.-hr. per month, $0.0425 per kw.-hr.

Comparisons with present actual costs, amounting to a total of $31,562 per year, indicates a saving of $4,282. If the suppliers of this equipment will accept payment from savings, the owner's investment cost may be reduced to $5,000, covering installation of piping, etc., and the carrying charges will be reduced to approximately $300 for interest.

Fig. 5 indicates the relative cost of steam and electric power, both on the basis of purchased steam and electricity and on the basis of purchased steam and generated electric power.

It is obvious that the larger building will show a much greater saving than the smaller units. As each building is subject to many variations in type of occupancy, steam and electric demand, a universal treatment of the problem is not feasible and only a complete individual study by competent engineers should be the basis for the installation of new equipment.

Mineral Oil and Graphite Lubricates Press Fits

By N. L. Rea
Construction Engineer, General Electric Company

GRANDFATHER and probably great-grandfather used lard oil for cutting threads, tapping and reaming because it was the only oil he had. He found it excellent for this kind of work and we have followed in his footsteps. It was, therefore, perfectly natural to use lard oil, or a mixture of white lead and lard oil, for pressing shafts in couplings or rotors. Prevention of cutting was desired and these were the best remedies known.

This reasoning was fine as far as it went because the shaft was pressed in to stay. "There was little chance of the shaft having to come out again and, anyhow, someone else would have to take it apart, so why worry?" Nowadays conditions have changed and thrust-bearing drivers have to be removed occasionally for repair or renewal and once in a while a revolving field, coupling, gear or pulley must come off its shaft to facilitate repairs, cleaning or adjustments.

We have found many cases where parts put together size and size, or with a light fit, have apparently grown together so that high pressures combined with local heating were necessary to get them apart. The surfaces have been found badly rusted and pitted and, worse yet, it was impossible to stop their rusting after it was once started.

This has resulted in thrust-bearing drivers wearing loose because of the metal of the drivers and shaft being eaten away. This rusting was usually laid to electrolysis, stray induced currents and other causes, and the real cause was overlooked.

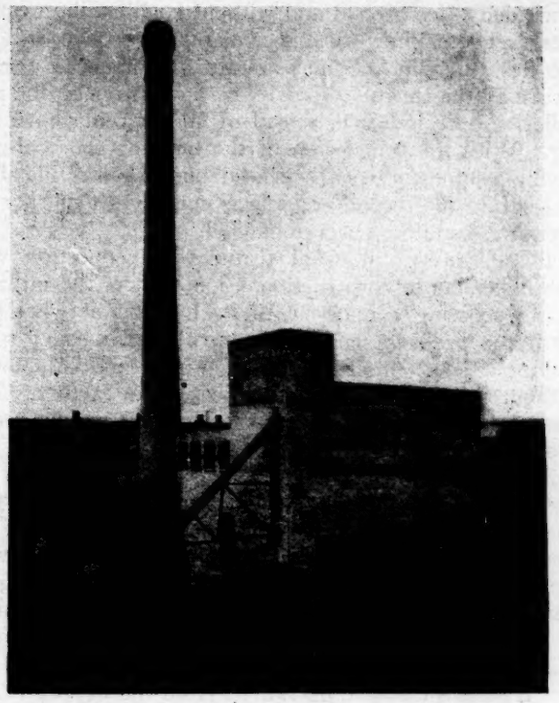
It took a long time to find the real culprit—lard oil. Lard oil becomes rancid with age and produces an acid that attacks the metal and rusting, once started, continues automatically. The particles of rust apparently act as catalyzers to take oxygen from the air and combine it with the steel.

Protective coatings such as oil or paint may slow up but cannot stop this action. The only remedy is to cut out the rust and get down to sound metal. The case has not been proved as yet, but we are also suspicious of the linseed oil in white lead.

As a result of our experience we are now using a pure mineral lubricating oil thickened with fine graphite for all pressing fits, and on the threads of hub bolts that are tightened hot. Any high-grade oil made by a reliable oil company is free from acid and can be readily tested with litmus paper, if one is suspicious. Heavy lubricating oil, vaseline or petroleum jelly have given good results when fine graphite was not available.

In all probability many of the greases are non-acid when new and will not go acid with age, but the amount required is so small that it is not worth while testing them. Pure mineral oil plus graphite give good results and can be obtained at small expense in the great majority of cases.

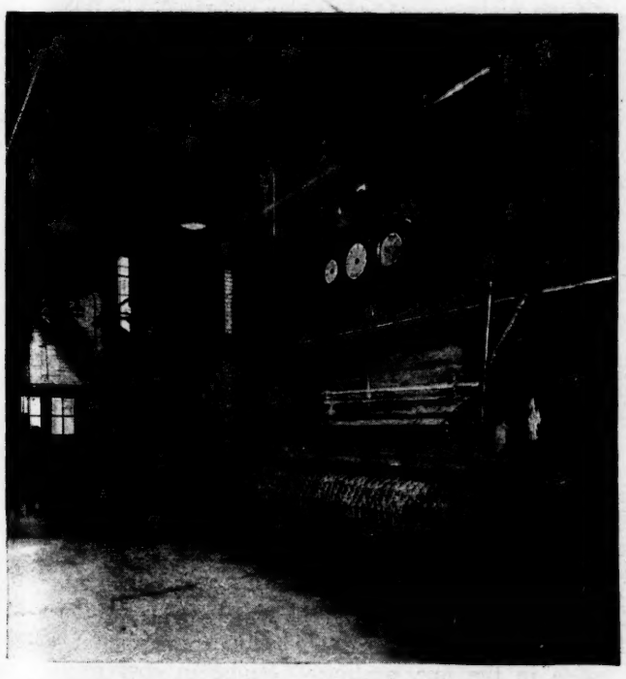
Service Maintained While Replacing Boiler House



Exterior of boiler house showing swinging coal and ash spout

THE factory of Wilson Brothers has been located in South Bend, Ind., for some forty years and during that time has had a steady growth until it now occupies nine buildings three stories in height and employs some 1,500 people engaged in manufacturing shirts, underwear and hosiery. The older portion of the factory buildings is a quadrangle arrangement with a power plant in its center, where originally a Corliss engine drove long belts and shafting in the surrounding buildings. About 25 years ago the Corliss engine belt was shortened to go around the pulley of a belted direct-current generator of 60 kw. capacity. Later, this generator with its engine was replaced by two four-valve engine direct-current units, and about three years ago, when both these machines were operating a little above their combined rating of 225 kw., a 2,300-volt synchronous motor driving a direct-current generator with central-station power was installed as a reserve.

With the factory the boiler plant grew piece by piece until last year, when four horizontal return-tubular boilers had all they could do to carry the load of the plant during the heating season. Exhaust steam from the engines is used for heating and for hot water, but in addition to this a large quantity of steam, much of it at high pressure, is required for bleaching, dyeing and washing the product. The steam demand was so great that at times the boilers could not provide as much steam as the factory could use.



The two 5,000-sq.ft. boilers are served by chain grates

The location of the power house was adapted to the original belt drive, but with the growth of the factory and the installation of a railroad siding, there was a gap of 100 yards between the siding and the coal bin, which added about 60 cents to the cost of every ton of coal burned. The roof over the boilers was only 18 ft. above the boiler-room floor, and the building itself was not suited to the housing of modern equipment. It was therefore decided to put in modern boilers and provide a suitable building.

A brick stack, 5x125 ft., served the old boilers and was located practically on the line of fronts at the north of the old boiler room. In the new arrangement the water-tube boilers were placed with their rear line almost on the stack line, with the fireroom to the south, the new fireroom being immediately outside of the old boiler room.

Under the new fireroom a basement was provided for handling ash, etc., and the work was started by excavating for this basement outside of the old building. When this underground construction was complete, two of the old boilers were removed and one-half of the old building torn down, leaving two boilers in service for process steam and the central-station reserve for factory power. Two new boilers of the bent-tube type were purchased, each having 5,000 sq.ft. of steam-making surface and served by a chain grate. One of these boilers was installed as rapidly as the foundations could be prepared, and the half of the boiler house that was to contain the steam header and the coal elevator was put up. When this boiler was in condition to carry load, the old and new headers were connected with temporary piping and the two remaining h.r.t. boilers with their building were wrecked. During the construction of the second half of the boiler house the first stoker was in operation with

truck deliveries of coal and without coal-handling equipment. The engines were at once put in service, and for the first time in recent years the factory was able to secure all the steam desired. The flow meter on the new boiler at once indicated a load of 50 per cent above rating. With the completion of the building the coal-conveying equipment with overhead bunkers was installed, and before the second boiler was entirely set up, normal operating conditions were obtained.

There are two unusual features in connection with this boiler-house construction. The first is the utilizing of the existing chimney with its location at what was formerly the front end of a return-tubular-boiler room and now is at the rear end of water-tube equipment, without interrupting steam service to the factory. The second notable feature is the method of handling coal and ashes.

As it was not possible to run the side track into the power-plant lot, the track was extended beside the factory building which formed the east line of the original quadrangle. A track hopper was installed on a line with the basement of the new boiler room and a belt tunnel constructed under this building and the yard, terminating in the elevator boot at the west line of the new boiler house. This belt is supplied by an apron feeder, and the coal travels a distance of 172 ft. from the hopper to the boot. From the boot the coal is elevated a height of 40 ft. to a screw distributor which extends the length of the overhead bins in front of the boilers.

At the elevator head a switch is provided so that when the bunkers are filled coal may be received and discharged through a swinging spout onto a reserve stockpile in the yard. To reclaim from this pile, coal is shoveled through a grating which is outside of the boiler house and discharges into the elevator boot.

Ash from the chain-grate stokers drops into pits, the bottoms of which are a little above the basement floor. The ashes are hoed from these pits into the boot of the coal elevator and discharged through the same spout that delivers to the coal stockpile, but the spout is at that time swung through an angle of 90 deg., so that the ashes may be delivered into a truck.

NEW EQUIPMENT OF WILSON BOILER HOUSE

Boilers, two water-tube, 5,000 sq.ft.	Hedges-Walsh-Weidner Co. (Combustion Eng. Corp.)
Stokers, Green chain grate, 99 sq.ft.	Combustion Engineering Corp.
Arches	M. H. Detrick Co.
Settings	National Power Construction Co.
Steam fitting	Kehm Bros. Co.
Pipe covering	General Asbestos & Supply Co.
Steelwork and bunkers	Elkhart Bridge & Iron Works
Soot blowers	Diamond Power Specialty Corp.
Coal-conveying equipment	Link Belt Company
Motors for conveyors	General Electric Co.
Motor control	Cutler-Hammer Co.
Flow meters	Republic Flow Meters Co.
Feed-water regulators, Copes	Northern Equipment Co.
Blowoff valves, Yarway combination	Yarnall-Waring Co.
Non-return valves	G. M. Davis Regulator Co.
General valves	Crane Company
Feed-water valves	Wm. Powell Co.
Safety valves	Crosby Steam Gauge & Valve Co.
Water columns	Reliance Gauge Column Co.
Steam traps	Boylston Steam Specialty Co.
Building contractors	H. G. Christman & Co.
Consulting engineer, design and supervision of construction	W. L. Fergus & Co., Chicago

Treat Low-Voltage Circuits with Caution

By Marin Phillips

A SWITCH or wire carrying 10,000 volts looks harmless, and is if you do not touch it. Do not touch it is a broad statement to make to electricians and maintenance men. When plants run six and seven days a week, it becomes necessary to work on live circuits, where there is always a risk involved. The extent of this risk depends on the precautions exercised by those doing the work.

If the work is rushed without taking the danger into consideration or the safety rules are disregarded, the risk will be high; when proper precautions are taken and the safety rules followed, the hazard is low. Workmen should always strive to remain on the safe side. In order to accomplish this it is necessary to play safe and be alert at all times. This can best be accomplished by treating all low-voltage circuits as if they were operating at high voltage. There have been many fatal accidents on low-voltage circuits that had been considered harmless not alone by those working around them, but by engineers in general. In such cases it is usually a matter of contact.

Workman Killed by 98 Volts Direct Current

A workman came in contact with a lighting wire while working in a wet place and was killed. The voltage was found to be 98 direct current. As this was a direct-current circuit, there was no possibility of a high voltage being suddenly developed in the circuit, as sometimes occurs with alternating current when the low-voltage circuit comes in contact with a high-voltage. This is sometimes due to an insulation failure in a transformer. Another fatal accident happened to a workman who, while inside of a boiler cleaning it, came in contact with the light extension cord. The voltage in this case was around 110 alternating current.

Ordinarily, 440-, 550- and 600-volt circuits are considered low voltages, and many workmen are inclined to think they are not sufficiently dangerous to require taking the proper precautions before doing work when the line is alive.

It is true that the low voltage will not kill outright as high voltage will, except in rare cases, but it will wear the victim out in case he gets in a position where he cannot release himself. The three voltages, 440, 550 and 600, should be classified as high-voltage circuits and treated as such by all who have to work on them. They are dangerous and will prove fatal if a good contact is made between wires or through the body to the ground. Enough fatal accidents on these so-called low-voltages happen every year in homes and in industries to bear out this statement.

Correction—In *Power* for April 23, 1929, an article was published entitled "Can Cheaper Power Be Obtained by Preheating Coal?", by W. R. Knapp and Paul McMichael. Through a misprint, certain plus and minus signs were transposed in Table VII of this article. In the line reading "Change in cost of power—mills" all the minus signs should be plus signs and the plus signs should be minus signs. This same correction should be made in the line reading "Change in cost of power" which appears two lines below the first correction.

What a Power Superintendent Does

This generalized form of instructions can be adapted to the needs of any plant by changes in wording

By Walter N. Polakov*

Consulting Engineer, New York City

THE AIM of this and following articles is to furnish the executive concerned with power-plant operation a set of co-ordinated patterns upon which can be elaborated a consistent managerial policy for his peculiar circumstances.

These instructions grew out of the author's experience in a large number of vastly different power houses during a score of years, both as an executive and as a consulting engineer, where they were worked out, introduced and withstood long trial, thus proving their practical worth.

They cover the most neglected corner in the field of industrial management. There are many textbooks and standard courses on combustion, fuels, chemistry of combustion, gas analyses and allied purely technical subjects of plant operation. There is also quite a library on calculation, design and construction of power houses and generating equipment. What is missing, however, in modern literature is a practical reference book telling how to organize the human side of the work in the power houses. Yet the need of such a text is broadly recognized. It is sufficient to glance over a few magazine articles picked up at random to see universal admission that the best of equipment in the best of plants falls short of its possibilities owing to some purely administrative hitch, or that the best-known methods prove disappointing because the organization weakness fails to make provisions for men to live up to it.

The assembly of instructions here presented covers two main groups of administrative problems—duties and functions.

It is not expected that these rules can be lived up to in every detail in any plant; but they are made so general as to permit modifications to suit any specific condition. A set of similar instructions, carefully worked out and painstakingly introduced into daily practice, should be adopted by every power engineer if he desires to make full use of his equipment and force at the lowest cost. To that end this set may serve as a pattern upon which specific cases may be based after due study and research.

The forms and other illustrative matter are likewise intended not for uncritical imitation, but chiefly as workable suggestions and illustrations of the reading matter.

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This and other instructions to be published in *Power* from time to time will set up standard management practice for the important jobs and functions involved in the operation of a power plant. The author has written these as a result of many years of experience. Power plant managers will find them valuable guides.

It has been invariably found in the writer's experience that such sets of standard practice instructions or organization write-ups intelligently adjusted to local peculiarities, nature of service and managerial policy, are not only a help to the operating and supervising force, inasmuch as they clearly define the principal duties and practices, thus avoiding uncertainties, conflicts and irritations, but prove an aid to general management in its tasks of supervising the work, removing obstacles and "breaking in" new employees with a minimum of time and money compatible with given circumstances and the desired degree of safety.

Duties and qualifications of the supervisory staff depend upon the size of the power plant. In small plants the chief operating engineer is vested with all supervisory duties. In larger plants a superintendent of higher qualifications as to education, experience and leadership is needed.

In case a company operates more than one plant, the plant superintendents report to the power supervisor or superintendent of plant operation or, in manufacturing concerns, to the general superintendent or executive engineer or other proper executive.

The following description of duties of the power-plant superintendent has been in use since 1913 in a public-utility central station, in a railroad central power house since 1915, and in many industrial power houses, in some of which these duties are combined with those of plant engineer or even master mechanic.

Duties of Power-Plant Superintendents

Purpose: This standing order is issued to define clearly the responsibilities and authority of the superintendents of plants or stations.

The Task: The superintendent sees that the plant is always kept in such condition that any time, with a few minutes' notice, the plant is able to throw into the system the amount of current equal to the rating of the plant, and no less than — per cent at the ——— station of the rating, and to maintain an uninterrupted service.

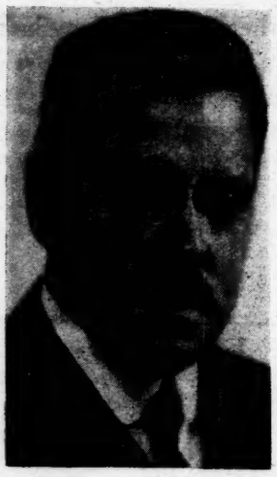
Efficiency: In living up to this requirement he is to see that the efficiency of utilization of the equipment is the highest compatible with the load and that all men live up to the task set for them. The efficiency shall not be less than — per cent at ——— plant.

Training: The superintendent sees that every man in his employ is trained to perform his duties in a standard manner and trains the men how to accomplish their tasks, either himself or through an expert in the particular line of work.

Bonus: The superintendent assumes the responsibility that all the men working under him clearly understand and closely follow the instructions prepared for them as to how to accomplish the task set. The superintendent, as a reward for training his men and maintaining the conditions which help them to accomplish the task, is offered a bonus for successful work as described in each particular case for each particular bonus job.

Revision of Standards: It is the duty of the superintendent to report to the planning department all such changes of physical conditions and otherwise which affect the accomplishment of the task, and he has the privilege of making his recommendations to revise either standard method or standard condition, but these recommendations shall always be in writing and supported by "Trouble Report."

Routine Work: The superintendent sees that every man employed at his plant performs his duties in the manner specified in the standing order or instruction card, and he is directly responsible to the firm for any case of unobservance of such regulations. He also sees that the storeroom, toolroom and emergency boxes are always in good working condition and are kept in accordance with the rules and orders. He checks daily the plant clerk's work and verifies with his signature that the reports and bonuses are figured correctly, and assumes full responsibility for any errors that may occur therein.



Walter N. Polakov

Maintenance: The power-plant superintendent is responsible for keeping all the machinery, equipment, buildings and structures in first-class working condition. To do so, he has the privilege of requesting various work which, in his opinion, must be done by the floating repair gang.

He also sees that all minor jobs of upkeep are done at the right time and in the right manner by the regular men in the employ of the plant. He pays particular attention to the safety and cleanliness in or about the plant and to the proper condition of fire-protective equipment.

Maintenance of dwellings and other structures on the property also come under his supervision, with the exception of such wires, towers and mains as come under the jurisdiction of the superintendent of lines and distribution.

Employment: The superintendent has the right to receive the application for a position open in his plant and to examine the applicant, and if the man is fit for any particular position, he prepares the application blank in triplicate, one copy of which goes to the plant file, another to the general superintendent and the third to the main office. When a position is vacant, the plant superintendent employs the fittest man, disregarding the time when the application was filed, and sends his application blank to the main office with the remark: "Employed from ——— 19— at ——— per week (or hour) to fill the position as ———," and receives in return the other copy of the man's application which indicates that the man was placed on the company's payroll.

If the position is new, the superintendent cannot employ the man unless he has written authorization from the general superintendent of the company to carry an extra man on the payroll. The request for the creation of a new position at the plant shall be addressed to the general superintendent, at which time it shall be clearly stated for what duty, for what period of time and at what compensation the extra man is required.

In case of immediate need of help to prevent loss of life or damage to property or crippling of the service, the station superintendent has the right to employ emergency help and notify the general superintendent after, in order to receive confirmation or to be otherwise directed.

Discipline: The superintendent is the plant disciplinarian. His authority extends to all the employees on the plant payroll, and also all visitors and contractors as well as contractors' men working within the plant premises. He has the right to remove from the property all and any persons whose behavior is dangerous either to themselves, to others or to the property, or whose conduct is objectionable. The superintendent has the authority to suspend or discharge any such employee who disobeys his orders or whose presence at the plant is otherwise undesirable. In all and every such case he reports to the general superintendent as to his action and reason thereof, for his information. The superintendent has no right to suspend or discharge any employee who is not on the plant's payroll or who works under the direction of another department. In case of insubordination of any such man, making his presence at the plant detrimental, he has the authority to request such person to report at once in person to the head of his department.

Purchasing: The superintendent sees that no delays in operation or maintenance are caused by lack of material or supplies, and he has the right to prepare the requisitions for purchasing any special or new stores as required, and will send these requisitions to the general superintendent for approval. He also has the right to examine the tags in the storeroom at the plant and to suggest the change of established minimum and maximum of stores items.

Petty Cash: For minor expenses he has on hand the sum of ——— per month for petty cash expenses, and he has the right to spend up to $5 per single item in case of emergency. In such case a confirming requisition must be sent through, marked "Confirming only." Expenses up to $1 for a single item of expense require no confirming requisition.

In preparing a statement of the petty cash expenses, each item above $1 is to bear the remark giving the reason why such purchase has not been made through the regular channel.

Substitutes: During the absence of the superintendent from the plant or premises the watch engineer assumes his duties as to the details of operation and discipline and the plant clerk as to the matters of office stores

and records. Neither engineer nor clerk, however, should be held responsible unless the superintendent, before leaving the plant, notifies them that they have to assume the afore-mentioned responsibility.

The night watch engineer also assumes full responsibility of the routine matters of the plant, but he has no right to undertake any extensive repair or overhauling work without written instructions.

Reports: The superintendent reports and receives orders, instructions and directions pertaining to the matters of operation from the general superintendent.

All matters subject to the planning of work shall be taken up with the planning department at the main office, or the consulting engineer.

In all matters pertaining to general policy the superintendent receives the instructions and directions from the general superintendent of the company.

In all matters where the authority of the station superintendent is insufficient to act on his own accord, he has to prepare recommendations in the form of "Trouble Report" and send it through for approval.

Boiler Efficiency Chart*

By C. A. KULMANN

THE accompanying nomograph gives a quick and accurate method of determining boiler efficiency with a minimum of effort. Combined with the author's nomographs for Factor of Evaporation and Steam Quality, solution of efficiency is made possible with but one slide-rule operation and the charts, and without reference to tables or handbooks. The only slide-rule operation is to determine the weight of water evaporated per pound of fuel. The equations used are,

$$H_a = 970.4\ FW$$
$$E = 100\ H_a H_f$$

where H_a is the heat absorbed by the boiler per pound of fuel, F is the factor of evaporation, W is the actual evaporation in pounds of water evaporated per pound of fuel, E is efficiency, and H_f is the heat per pound of fuel.

To use the chart, lay a straight-edge from the proper value of evaporation to that for factor of evaporation and note the intersection on the B.t.u. absorbed or equivalent evaporation scales. Connect this point with the known value of B.t.u. per pound of fuel and read efficiency. When using the right-hand scale of calorific value of fuel, use the right-hand efficiency scale.

Thus, if one pound of 14,000 B.t.u. coal evaporates 10.2 lb. of water when the boiler is operating with a factor of evaporation of 1.1, the boiler efficiency can readily be found from the chart by first connecting with a straight-edge the point 10.2 on the evaporation scale with the point 1.1 on the scale for factor of evaporation. The intersection on the second left-hand scale shows that 10,900 B.t.u. were absorbed by the boiler per pound of fuel or that the equivalent evaporation was 11.2 lb. of water per pound of fuel. By connecting this point with 14,000 B.t.u. on the scale for the heating value of the coal, the intersection on the efficiency scale shows the efficiency to be 78 per cent.

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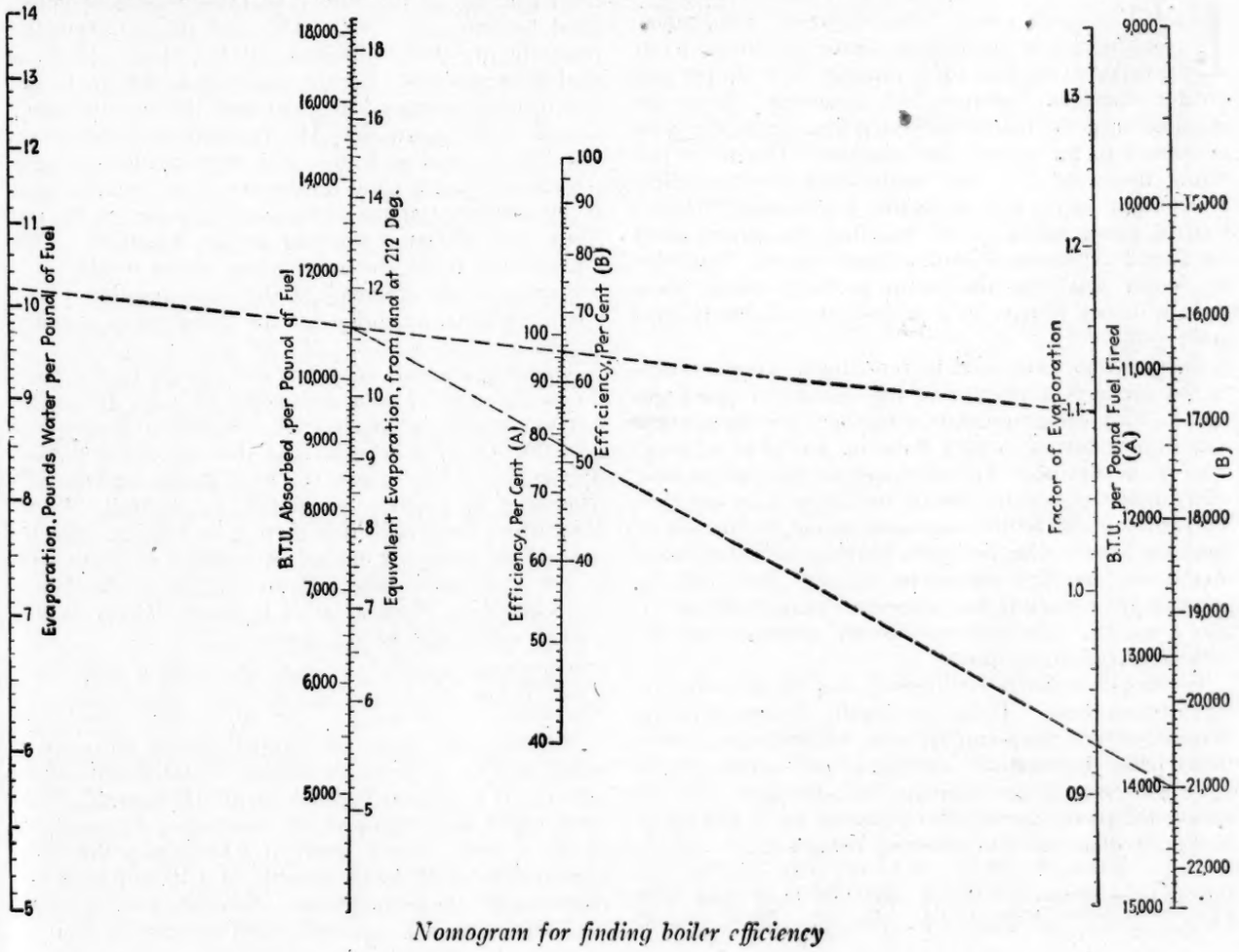

Evaporation. Pounds Water per Pound of Fuel
B.T.U. Absorbed per Pound of Fuel
Equivalent Evaporation, from and at 212 Deg.
Efficiency, Per Cent (A)
Efficiency, Per Cent (B)
Factor of Evaporation
B.T.U. per Pound Fuel Fired
(A)
(B)

Nomogram for finding boiler efficiency

How to Apply Performance Curves to Pump Installations

By M. J. Reed
Stonehurst, Pa.

Whenever the wrong pump is installed for a given job, there is necessarily lost a considerable amount of energy that could have been saved if a little engineering study had been given to the selection of a proper size unit. This article shows that the use of performance curves for selecting the proper pump is not difficult.

I ONCE knew a pump "sales engineer" who, whenever the size of the driving motor permitted, wrote the order to his firm for a capacity 15 to 20 per cent greater than the customer had requested. After the installation of the pump this young man made it a point to remark to the power-plant engineer, "Doesn't it just throw the water?" This might have been excellent psychology, but it was deplorable engineering. Doubtless the young man's excuse was that few buyers allow for future expansion in stating requirements. But what he forgot was that the pump probably *threw* away enough money to pay for a second pump the very next year.

Engineering, as applied to centrifugal pumps, means to the average technical man the subject of pump design. Pump design presents a big field for the application of engineering, and I have no intention to minimize its importance. However, centrifugal pumps have uses outside of drawing rooms and away from test pits. To justify manufacture they must be put on the job of pumping water. Our designers have accomplished much in the way of high efficiencies in late years, but the value of their work is lost whenever a pump is selected for a specific duty with a slovenly disregard of the optimum head and capacity.

To supply a pump intelligently one should have its performance tests. These are usually presented in the shape of curves, the pump pressure, efficiency, and sometimes brake horsepower serving as the ordinates for these curves with the capacities as abscissas. For instance, the pump characteristics plotted for 1,150 r.p.m. in Fig. 1 illustrate the following conditions:

Capacity, gallons per minute	0	500	1,000	1,500	2,000	2,500
Pump pressure in feet of water	115	114	112	106	92	68
Efficiency, per cent	0	35	60	70	74	66

All this means that when the pump is acting against a 106-ft. head of water, the capacity will be 1,500 g.p.m.—provided the speed be 1,500 r.p.m. Fig. 1 does not show a brake-horsepower curve. Brake-horsepower is easily arrived at from the simple expression,

$$\text{B.H.P.} = \frac{\text{head in feet} \times \text{gal. per min.}}{3{,}960 \times \text{efficiency}}$$

and in the example selected, where the efficiency is 70 per cent horsepower is 57.8

If the speed of the pump were increased or decreased, the curves expressing the relation between the head and the capacity would be raised or lowered. The rule is that the capacity varies directly with the speed, while the head varies with the square of the speed. If the speed of the pump in Fig. 1 is increased to 1,450 r.p.m., the capacities in the foregoing table should be multiplied by the ratio 1,450/1,150, and the corresponding heads by the ratio $(1{,}450/1{,}150)^2$. Thus, 115 ft. at shutoff becomes 182 ft.; the condition at 500 g.p.m. and 114 ft. head becomes 630 g.p.m. and 181 ft.; the condition at 1,000 g.p.m. and 112 ft. becomes 1,260 g.p.m. and 178 ft.—and so forth. For slight changes in speed the efficiency of a point on the new curve will be equal to the efficiency at the corresponding point on the old. Thus, the efficiency applying at the condition (1,890 g.p.m.—170 ft. on the 1,450 r.p.m. curve would be 70 per cent, or the efficiency at the corresponding (1,500 g.p.m.—107 ft. condition on the 1,150 r.p.m. capacity curve.

The next question is, What will this particular pump do in the way of capacity output in a given system? Let us assume that the system in question is composed of 1,000 ft. of 8-in. pipe and that the point of free discharge is 75 ft. above the level in the suction well. The head at no-flow, or shutoff, is obviously 75 ft., since where there is no flow there is no friction. But the head of the system at any other condition is a compound of the 75 ft. static head and the friction of the flow in the 8-in. pipe. From a set of hydraulic tables, the following values can be set down;

Capacity, g.p.m.	0	500	1,000	1,500	2,000
Static head, ft.	75	75	75	75	75
Friction, ft.	0	8.2	29.7	62.5	107
Total head, ft.	75	83.2	104.7	137.5	182

If these total heads are plotted against the capacity values in Fig. 1, the curve labeled "Total Head" can be drawn. It is obvious that any pump will operate at that point where the pump pressure overcomes the resistance of the system. For a speed of 1,150 r.p.m. this point is seen to be at *A*, and a capacity of 1,100 g.p.m. would obtain under these conditions. For the increased speed of 1,450 r.p.m. the capacity would increase to that ob-

taining A', or 1,860 g.p.m. Observe that the relation of A' to A has nothing to do directly with the ratio 1,450/1,150. The ratio is first used to set up a new curve for the changed speed condition. The new capacity is then found at the intersection of the "Total Head" curve with this new pump head curve.

The system represented by the "Total Head" curve in Fig. 1 was assumed to be the simplest possible; that is, a

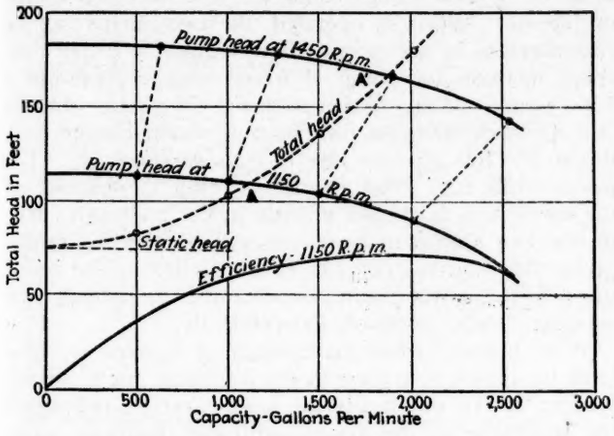


Fig. 1—Pump performance curves showing effect of change in pump speed

straight length of pipe with no losses from elbows, fittings, valves and entrance. However, this in no way affects the value of the illustration. As a matter of fact these losses could have been resolved into equivalent lengths of 8-in. pipe, which would have reduced the problem to the same terms. Let us assume that these extra losses have been resolved into equivalent pipe lengths in the system shown in Fig. 2. We then have a system starting with a common 8-in. line, the friction in which is equal to 2,000 ft. of pipe and branching at a point 50 ft. above the suction well into two lines. Branch A terminates with a free discharge 90 ft. above the suction well and is equivalent to 200 ft. of 5-in. pipe; branch B terminates with a free discharge 80 ft. above the suction well level and is equivalent to 400 ft. of 6-in. pipe.

Since all the water that passes through the pump must also pass through the 8-in. common line, the total head curve for that part of the system can be directly plotted, starting with the 50 ft. static head for this common line. From tables the figures are:

Capacity, g.p.m.	0	500	1,000	1,500
Static head, ft.	50	50	50	50
Friction head, ft.	0	16	59	125
Total head for common line, ft.	50	66	109	175

Plotting these values, we have the curve labeled "Total Head of Common Line."

The total head loss in the branching lines must be indirectly determined. The first step, however, is to plot the total head curve of each branch line as done for the common line. The static head to use in each case is, of course, the static head from the point of branching to the point of free discharge. We have for branch A:

Capacity, g.p.m.	0	500	1,000	1,500
Static head, ft.	40	40	40	40
Friction, ft.	0	16.2	58.4	120.0
Total head of A ft.	40	56.2	98.4	160

and for B:

Capacity, g.p.m.	0	500	1,000	1,500
Static head, ft.	30	30	30	30
Friction, ft.	0	13.4	48	101
Total head for B, ft.	30	43.4	78	131

These two sets of values give us the two curves labeled "Total Head of Branch A" and "Total Head of Branch B" respectively. Now it is evident that no water will flow through line A until the pressure at the point of branching exceeds the static head of 40 ft. Therefore, the total head curve for the two branches in parallel is identical with the total head curve for branch B until the value of 40 ft. is reached. Above this point water will flow in both branches, and the problem is to discover how the flow will divide. The principle to follow in determining this is that the flow division must be such that the head loss is the same in either branch. This follows from the fact that both lines start from the same pressure, the pressure in the common line at the point of branching, and terminate at the same pressure, atmospheric. A horizontal line will cut these two total curves at points of equal head. Such a line is shown cutting these curves at a head of 47 ft. The capacity flowing in branch A for this head is X g.p.m. and in B, Y g.p.m. Therefore, the total water passing through both A and B is $X + Y$ g.p.m. with a head loss of 47 ft. If this horizontal line be extended to the right, the capacity $X + Y$ will intercept upon it a point on the curve of the total head of the two branches in parallel. In similar fashion other points can be located and the curve labeled, "Total Head of A and B in Parallel" can be drawn through them.

Since the common line is in series with the system composed of A and B in parallel, the total head curve of the entire system is found by adding the ordinates of the head curve for the common line to the ordinates of the total head curve of A and B in parallel. This procedure results in the curve labeled "Combined Total

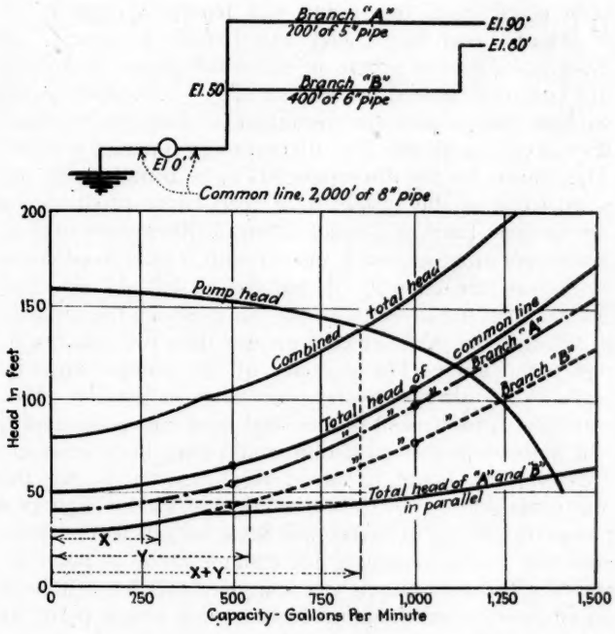


Fig. 2—Method of finding flow in branch lines

Head," and the point at which this curve intersects the pump characteristic gives us the capacity of the system for that particular pump. It will be seen that the pump will pass 850 g.p.m. through this system, and of this 300 g.p.m. will pass through branch A and 550 g.p.m. will pass through branch B. These capacities for A and B will hold under these conditions unless the friction in one line or the other is changed by closing a valve,

which would be the method used in practice to obtain a different distribution.

It is just as possible to add pump characteristics as it is to add head curves. In Fig. 3 are shown the results obtained by operating two identical pumps in series and in parallel. To obtain a curve representing the pumping characteristics of the plant when the pumps are paralleled, the capacities are doubled for corresponding heads; when the pumps are run in series, the heads are doubled for corresponding capacities. Thus, for a head equal to Y one pump will handle a capacity of X g.p.m.; two in parallel will handle a capacity of $2X$ g.p.m.; or two pumps in series will pump a capacity of X g.p.m. against a head of $2Y$. Operators often parallel pumps and are disappointed that the resultant flow is not twice the flow of one pump operating alone. The reason for the discrepancy is to be found in the upward slope of the system total head curve produced by the variable friction element. Thus, if the pumps of Fig. 3 are operating against a system with a total head curve as shown, the capacity in parallel is but 22 per cent greater than the capacity of one pump alone; the capacity in series is but 30.3 per cent greater than the capacity of one pump alone. The capacity of the pumps when in series is not always greater than when in parallel. This condition is influenced by the total head curve, for had it had more slope this condition would have been reversed. However, it should be noted that capacity is not the only index to go by in cases of this kind. The two pumps operating in series will have an efficiency corresponding to that obtaining for a single pump at point B', whereas the two pumps operating in parallel will have an efficiency corresponding to that of a single pump at point A'. The chances are that for the pump characteristic shown the efficiency will be considerably higher at A' than at B'. Therefore, the two pumps will produce the greater capacity in series at the cost of the poorer efficiency. This, also, is not necessarily always the case, and each problem must be judged upon its merits.

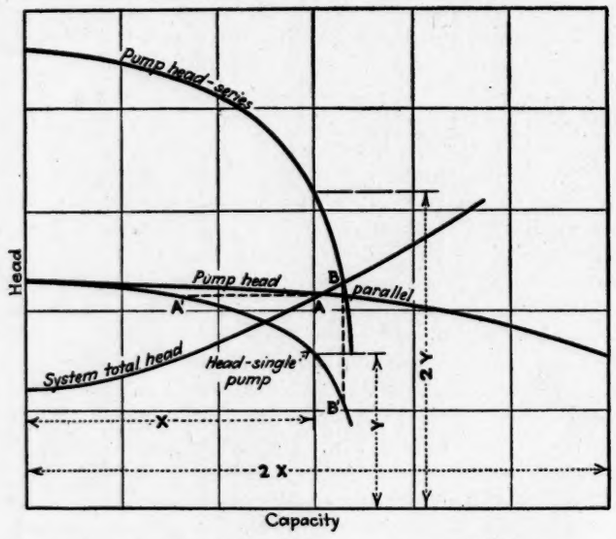


Fig. 3—Combined head-capacity curves when pumps operate in series or in parallel

It is not necessary that pumps be identical before they can be operated in series or in parallel. In Fig. 4 the case of a low- and a high-head pump in series is illustrated. Of course it is not always possible to operate dissimilar pumps in series or in parallel. Suppose a case of a pump similar to pump A in the figure and a pump with a capacity up to 1,000 g.p.m. If these two were to be connected in series in a system wherein the larger pump alone would normally handle around 600 g.p.m., the series operation would not be successful[1]; just as a parallel connection of pump A and pump B would not be a success for heads over 65 feet.

The case of Fig. 4 can also be used to illustrate the behavior of two pumps connected to a common motor or turbine. When so operated, the two pumps can be considered to be one pump. For example, a 10 per cent speed increase for pump A would change condition a (160 g.p.m.—35 ft.) to condition a' (176 g.p.m.—42 ft.) and the same increase for pump B would change condition b (160 g.p.m.—110 ft.) to condition b' (176 g.p.m.—133 ft.). But the same result is obtained if the speed ratio is applied directly to the combined curve of the two pumps in series, as will be seen by multiplying the head at c, or 145 ft. by $(1.10)^2$. The result of 175 ft. is the same as obtained by adding the separate heads, obtained independently.

What happens when the capacity of a pump is regulated by means of a valve in the discharge line is shown by Fig. 5. In this figure the head curve S_1 represents the resistance of the system with the discharge valve open wide. The other curves, S_2 to S_6 represent the system resistance with successive closings of the valve. Incidentally, this figure demonstrates a situation that is puzzling to many pump users. It will be seen that

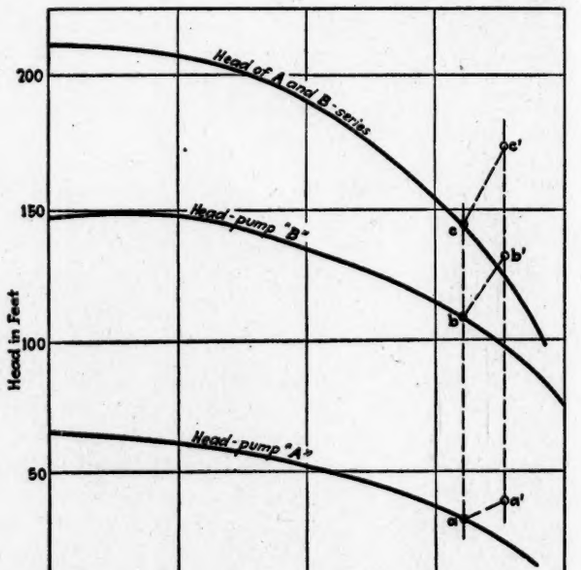


Fig. 4—Effect of operating low- and high-head pumps in series

the pump head is the same at both a and b, due to the downward curve of the pump characteristic near the shutoff condition. It might appear that as the discharge valve is gradually closed to the a condition, the pump would discharge the capacity normally obtaining at point b. However, the two points lie on entirely distinct total head curves; as far as the resistance of the system is concerned, there could be no confusion of the conditions

[1]Of course, if the smaller pump were second in line, it might contribute *something* to the operation.

at *a* with the conditions at *b*. Of course the pump itself becomes somewhat unstable in its operation very near shutoff; but that is a condition apart from these considerations.

From Fig. 5 it will be seen that throttling the discharge line is a method of regulating capacity that is rather wasteful of head. The ordinates intercepted between the curve S_1 and the intersections of the curves S_2 to S_6 with the pump head curve represent the amounts of head that are wasted at the various valve positions.

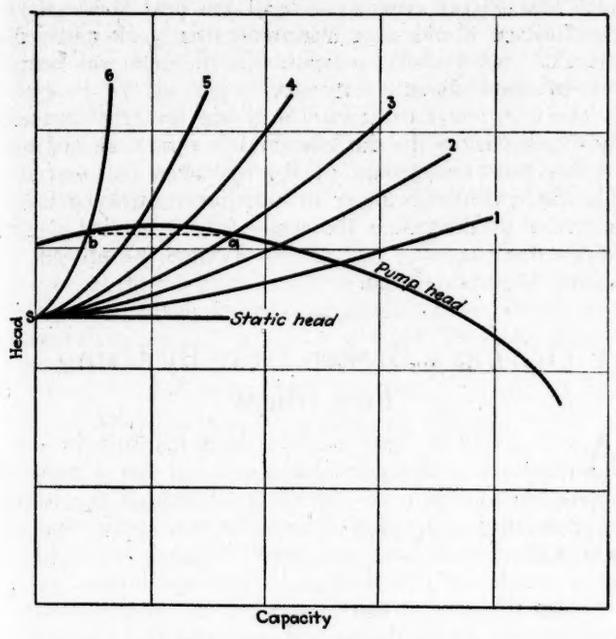


Fig. 5—Effect of throttling pump discharge

When a pump is turbine driven, some of this head loss can be avoided. A constant-pressure regulator will not operate a pump on the friction-total head curve, but it will prevent the pump head from increasing above the regulator pressure, which is, of course, the pressure at full capacity. Fig. 6 illustrates the operation of a pump governed by a constant-pressure regulator. The pump shown is for a full-load condition of 190 g.p.m. and 280 ft. total head. This condition is secured at a speed of 2,900 r.p.m. The full set of head conditions for this speed is shown by the curve labeled "Pump head—2,900 r.p.m."

A constant-pressure regulator cannot hold the exact 280-ft. head—such a requirement would not allow a regulating range. Suppose that the regulation of the regulator is 20 ft. of pressure. This means that at shutoff the regulator makes the pump hold 300 ft. pressure. A line drawn through 300-ft. head at shutoff and the full load condition (190 g.p.m.—280 ft.) will, therefore, illustrate the pump head under control of the regulator. To arrive at the pump speed for a condition less than full load, it is necessary to work across to the constant-speed pump curve. For example, to find the speed at which the pump handles 100 g.p.m. against 290-ft. head—a condition on the curve of the pump head when the pump is governed—we must try to discover the point on the constant-speed head curve, to which this corresponds. Suppose we try comparing 100 g.p.m. with 120 g.p.m. If we apply the ratio $(120/100)^2$ to the head of 290 ft., we have a head of 418 ft. But condition (120 g.p.m.—418 ft.) is not on the constant-speed curve. Therefore, we have made the wrong assumption with regard to capacity. But, if we compare the 100 g.p.m. condition to a 110 g.p.m. condition and apply the ratio $(110/100)^2$ to the head of 290 ft., we obtain 350 ft. It will be noted that the condition (110 g.p.m.—350 ft.) lies on the constant-speed curve, proving that the two points are analogous. The speed for the lower condition is therefore $100/110 \times 2{,}900$ or 2,640 r.p.m. If this process is repeated for a few selected points, the curve labeled "Speed—R.P.M.—Governed" can be plotted. Now, if the brake horsepower is calculated for these points, a curve of brake horsepower can also be plotted. For instance, the efficiency for the condition (100 g.p.m.—290 ft.), already referred to as lying on the constant-pressure governor curve, is the efficiency that obtains at the analogous point on the constant-speed curve, or 53½ per cent. The brake horsepower is, therefore, $\frac{100 \times 290}{3{,}960 \times 0.535}$ or 13.7. The dotted horsepower curve in the figure illustrates the horsepower for constant-speed operation. It will be seen that the use of the constant-pressure regulator saves the difference between 17.8 and 13.7, or 4.1, horsepower, at the condition of 100 g.p.m. If the steam characteristics of the turbine are known, it is a simple matter to erect a curve showing the total steam consumption throughout the range of pump operation. In Fig. 6 the speed curve has been extended to show the speed for a condition of 236 g.p.m. However, unless the full-load condition point contains some throttled head, such an overload condition could not be arrived at because it would be below the total head curve of the system. If the condition point (190 g.p.m.) lies on the total head curve when the discharge valve is completely open, the governor will not allow of a greater capacity, since a capacity increase would raise the pressure.

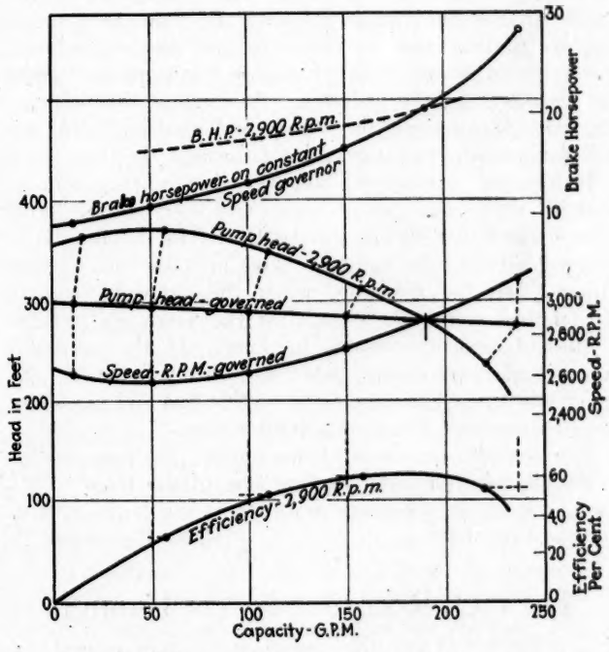


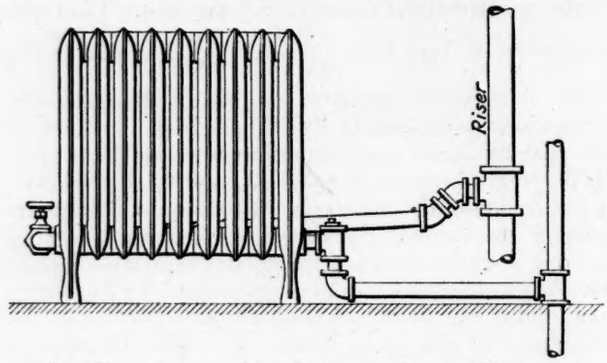
Fig. 6—Effect of pressure regulator on pump speed and horsepower

Engineers should have no difficulty in applying the simple methods outlined in the foregoing to the special problems of pumping that fall under the general cases discussed. And the imaginative engineer should be able to extend these methods to unusual pumping conditions.

Right Out of the Plant

Incorrect Radiator Piping Causes Water Hammer

SOME time ago I took a position as engineer in one of New York's older hotels. After a few months of service the management told me that several of the guests had complained of a disagreeable water hammer in the radiators when they were turned on in the morning. Upon investigation, I discovered that in these



A radiator connection that caused water hammer

particular rooms the radiators had been connected as shown in the illustration. As will be seen, the branch line to the radiator is connected to the steam riser through two 45-deg. fittings, and that it is pitched from the riser toward the radiator. As long as the valve at the radiator is opened, the steam condensed in the branch will drain to the radiator and out through the trap.

It is quite customary, however, for hotel guests to shut off their radiators at night, and when this is done it is evident that the steam condensed in the branch is trapped between the radiator valve and the two 45-deg. fittings. In the morning, when the valve is opened, the trapped water surges against the valve and creates a most disagreeable water hammer. If the occupant becomes alarmed at the racket and closes the valve, the water will surge back and forth in this line and the water hammer continue for a considerable time.

The remedy, of course, is to remove the trap in this branch line by pitching the line toward the riser. This may be done in whatever way seems most convenient.

New York City. P. R. BROCKNER.

The CO_2 Recorder Is Not Enough

IN DISCUSSING the question on the subject of steam-flow air-flow meters in the April 16 number, M. W. Horley stated, in the third paragraph of his article, "A leaky baffle will not show up on the air-flow steam-flow record, and usually when this occurs the CO_2 reading will be affected immediately."

No CO_2 instrument will indicate a leaky or broken baffle, because the course which the gas takes through a boiler, whether over, under or through the baffles, will not change the quantity of CO_2 in the gas.

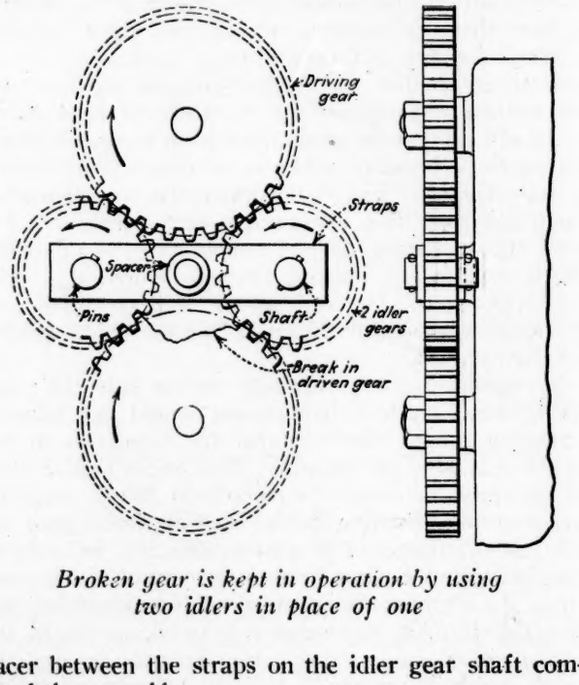
In his last paragraph he said, "The CO_2 meter is a recorder of all the losses going out the stack at all times." I do not agree with him at all in that statement. The condition of the baffles and boiler tubes could be such that 50 per cent or more of the heat liberated in the furnace would pass directly to the stack and still the CO_2 meter would indicate that the fuel was being burned efficiently in the furnace.

The CO_2 meter can record only one loss, that caused by excess air in the furnace, and it cannot record all of this loss, on account of the hydrogen in the fuel. The flue-gas thermometer or pyrometer must be used in order to determine the loss of heat carried away by the flue gas. IVAR S. KINDBERG.

Iron Mountain, Mich.

Driving a Broken Gear By Using Two Idlers

A CAST-IRON gear on a certain machine in our plant was so badly broken by accident that it seemed impossible to repair it. About one-eighth of the teeth were missing. In order to keep the machine in operation while a new gear was being obtained, we decided on a rather novel method of driving the broken gear. Between the driving and driven gear an idler gear was used, so we removed this and procured two old gears of the same pitch. Next, we cut off two steel straps and drilled one hole in the center to fit the fixed shaft on which the regular idler gear ran, and two holes near each end to take two short shafts for the new idler gears. Pins through both ends of these shafts and a



Broken gear is kept in operation by using two idlers in place of one

spacer between the straps on the idler gear shaft completed the assembly.

The broken gear was thus driven by the two idler gears, so that while the break in the gear was passing over one idler gear, the other idler was doing the driving. A study of the drawing will show how the drive was taken up by each idler gear alternately as the broken part passed from one to the other.

Hamilton, Ont., Canada. A. KENDALL.

Anchoring and Draining Underground Steam Lines

I HAVE read with interest H. A. Ward's discussion on the article appearing on page 921 of the Dec. 4, 1928, number of *Power*. It appears to me that Mr. Ward has overlooked Mr. Davidson's suggestion that the point of pipe anchorage be located between two expansion joints. When this is done, the thrusts produced by the expansion joints oppose each other, thus relieving the anchor of this thrust.

When the anchors are located in this manner they are only required to hold the pipe in place and need not be made heavier than as indicated in Mr. Davidson's article. In case, however, a valve is located in the line between the expansion joint and the anchor, a heavy thrust will be exerted on the anchor whenever this valve is closed. Under such circumstances a heavier anchor should be designed.

P. B. RANDALL.

New York City.

Power From Process Steam

I HAVE read with interest the article on "Power from Process Steam," by L. H. Morrison, in the March 12 number. The picture drawn is quite pleasing and very optimistic, especially as it makes the factory owner feel he is getting something for nothing.

However, this being more or less a practical age you do not get something for nothing very often, and I believe if Mr. Morrison takes into consideration the following, he would also agree that the factory owner cannot get his power for nothing.

In estimating the heat left in the exhaust, it is assumed that the steam engine or turbine will operate at 100 per cent Rankine efficiency. I do not believe that even the most enthusiastic salesman would claim that for his engine or turbine.

In the article it is stated that the heat transformed into work in the engine is not obtained for nothing, as a slightly greater amount of coal must be burned. However, nothing is said about the operating costs of the engine, such as fixed charges on the equipment, additional labor required, additional cost of lubrication, repairs and maintenance in the engine equipment, the higher maintenance cost of the steam equipment due to higher pressure, and other items that must be considered as cost of power generation and that tend to offset the idea that the factory owner can generate power for almost nothing.

I believe an article of this kind is rather misleading, as the factory owner may or may not be an engineer, and if he is not and reads this article, he will probably be greatly influenced by it on account of its being published in *Power*, and the impression that he will receive of power generation will not be a true one, owing to the important items mentioned having been omitted.

F. A. COLLINS,

Cincinnati, Ohio. The Union Gas & Electric Co.

IN HIS letter F. A. Collins states that even the most enthusiastic salesman would not claim for his engine or turbine a 100 per cent Rankine efficiency. Quite true, but there is little relation between Rankine efficiency and the heat removed from steam per kilowatt-hour. Rankine efficiency is the percentage of the available adiabatic drop that is turned into useful work. Where the exhaust is thrown to a condenser or to waste, there is a very definite relation between Rankine efficiency and fuel economy. In such cases, if the Rankine efficiency is reduced from 100 to 50 per cent the fuel consumed per kilowatt-hour will be doubled.

This does not apply at all when the exhaust steam is used in process work. The reason is that all the losses that cause the Rankine efficiency to fall below 100 per cent are returned to the exhaust steam in the form of heat, with the exception of such external losses as radiation from the cylinders, friction of the bearings and electrical losses in the generator. All these combined are only a small portion of the losses. In generating power every turbine, regardless of its efficiency, converts 3,415 B.t.u. into a kilowatt-hour. The rest of the heat in the steam feed, excluding the minor losses, is in the exhaust steam, and 4,000 B.t.u. may be taken as the heat actually used in delivering a kilowatt-hour at the switchboard.

We now come to Mr. Collins's second point. Allowing for the usual boiler efficiencies, 4,000 B.t.u. will almost always be less than a half pound of coal chargeable against the production of a kilowatt-hour. Mr. Collins is perfectly right in saying that the cost of such power must include not only the coal, but fixed charges on equipment made necessary by the generation of power. Nothing in the article contradicts this.

It is a fact, however, that where the power output is reasonably large, byproduct power is generally produced at an extremely low cost after including all the charges mentioned. The additional cost of a byproduct power plant over one designed to produce process steam alone, is far less than that of a complete power generating plant of the same size. The increased labor required is generally small. These are the usual conditions where the process and power loads are substantially large. When they are very small it is another story.

It has been frequently pointed out that each case must be figured by itself, counting in all elements of cost and saving.

L. H. MORRISON.

Loose Motor Connection Causes Light to Flicker

A THREE-PHASE alternating-current slip-ring motor connected to its load by a belt gave considerable trouble owing to conditions that should have been remedied before the machine was started. Within six months after its installation it was necessary to renew the bearings and locate the rotor central in the stator bore. This trouble was caused by misalignment of the rotor in its bearings. The next mishap occurred while the motor was running at night time. The lighting circuits were taken from the same line as the power for the motor. A flickering of the lights developed and at the same time a noticeable swing of the ammeter needle occurred.

When the motor was shut down it was tested and a partial open circuit was found in the rotor winding where two of the phases were joined. This connection had been made by soldering four conductors into a connector, two in parallel from each of two phases. Two of the conductors from one phase had worked loose and their ends could move in the connector. The belt had a bad joint in it, and each time it passed around the motor pulley it jarred the rotor. This shock caused the two loose ends of the winding to separate and produce a fluctuation in the current at each revolution of the belt.

Brentford, England. W. E. WARREN.

Pointers on Making Boiler Manhole Joints

I CANNOT agree with some of the remarks made by W. E. Warner in his letter on "Pointers on Making Boiler Manhole Joints" which appeared in the March 12 number. I refer especially to the first paragraph in which he says, "The thinner the ring or gasket used to make a joint of this kind the better."

In this country we are having excellent results with comparatively thick boiler manhole gaskets, particularly the flexible metallic variety. These gaskets are proving satisfactory because of the thickness that Mr. Warner decries. Thickness is what permits the elasticity of a really elastic gasket to be effective. A thin gasket cannot be effectively elastic.

With a first-class gasket of this type it is not necessary to smear white lead, graphite or other mixtures on its sides to make it tight. It conforms perfectly to the metal excepting of course in extreme cases. It is not claimed that even these thick gaskets will prevent leakage under all conditions.

W. F. SCHAPHORST.

Newark, N. J.

Oil Engines for Refrigerating Plants

REFERRING to the question asked by C. F. X. in the April 23 number, concerning the use of one or of two oil engines for a variable-load refrigerating compressor, I believe that the choice between one or two engine-compressor sets for an ice plant is determined primarily by the degree of reliability required in the particular plant being considered. Even the best makes of compressor sets are subject to minor breakdowns, but as the demand for power in an ice plant differs from the demand in a refrigerated warehouse, a temporary interruption does not result in destruction of stored valuables.

But the busiest season for ice plants is in the summer, during which season 24-hour peak production is usually necessary and the horsepower per ton of ice is greatest. For such an installation the use of two independent engine-compressor sets, properly maintained, will provide practically 100 per cent reliability against power failure. However, where an outside utility provides breakdown service at reasonable rates, the use of only one engine is sometimes warranted. When considering such breakdown services, it should be borne in mind that the interest on the difference in first cost of the one- and two-engine sets plus the difference in maintenance costs must equal or exceed the annual charge for breakdown service. This is seldom the case, since the utility must usually charge high rates for breakdown service, and since the first cost of two 60-hp. sets, for example, is usually only 5 to 15 per cent greater than the first cost of one 120-hp. set, especially if the total cost for auxiliaries, cooling system and building is considered. The maintenance charges for the two 60-hp. sets will not usually exceed $80 a year more than for a single 120-hp. set.

Nevertheless, assuming that occasional service interruptions are permissible, especially where ice-storage capacity is available or breakdown service is cheaply obtainable from an outside utility, the use of a single engine-compressor set has advantages.

It is well known that the fuel economy of an oil engine decreases rapidly if the load torque is decreased below 60 per cent of the full-load torque, but the fuel economy at constant torque and decreasing speed remains nearly constant at the rated value, until the speed drops below 33 per cent of the rated speed. This maintained economy with decreased speed is due to the fact that the increased volumetric efficiency balances the slightly increased heat losses per cycle. Therefore the over-all economy of a single-engine or two-engine installation would be approximately the same.

But the first cost and maintenance cost of the single-engine installation would be appreciably lower. The probability of shutdown of the single engine-compressor unit exists, and the two-engine-compressor installation provides practically complete reliability of service for at least 60 per cent of full rating.

Therefore, the question is determined primarily by the required degree of reliability against temporary power failure.

R. E. BRUCKNER, Research Engineer,
Ingersoll-Rand Company.

Phillipsburg, New Jersey.

Laying up the Heating Plant for the Summer

AFTER the heating season is over and the plant has been shut down, there follows a period of three or four months of idleness during which more damage to the heating equipment may be done than normally occurs during the whole winter season unless reasonable provisions are taken to protect equipment during the summer. If, on the last day of the season, the equipment is left in the same condition as when shutting it down over a week-end in the middle of the season, one should not be surprised to experience trouble when starting the plant the following fall.

Attention should first be given to the boilers. The ashpit, grate and flues should be cleaned in order to prevent corrosion from the sulphur contained in the refuse. Water should be drained from the boiler and the water surfaces cleaned as much as possible. All water-column plugs should be removed and the pipes inspected.

The pumping equipment should be looked after next. All the packing should be removed from the piston and valve-stem rods of steam-driven reciprocating pumps, as the old packing will tend to harden during the summer and, if used in the fall, may cause considerable wear on the piston and valve-stem rods. The valves in the water end of the pumps should be looked over and, if badly worn, should be renewed. The cylinder heads of pumps and engines should be taken off and the cylinder smeared with oil. By working the piston back and forth several times, the piston will also be oiled. If no repair work is now necessary, put the cover back on and draw up tight to be ready for next season. The engine slide valve should be taken out and the valve slide oiled, and the valve should be oiled and put back in place. All polished parts should be swabbed with cylinder oil.

All steam and oil traps should be taken apart, cleaned and examined to see whether they are in good working condition. These traps are likely to leak more or less without the engineer's knowledge, and this affords a good opportunity to find out and correct it. Pressure-reducing valves should be taken apart, the water in the dashpots removed and the piston or plunger and cylinders oiled. Where belt drives are used, the belts should be taken off the pulleys and put away.

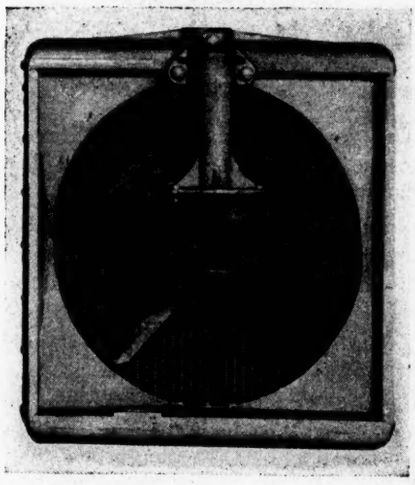
Duluth, Minn. NELS HILSEN.

What's New in Plant Equipment

HOW THE MANUFACTURER CONTRIBUTES TO THE JOB OF GENERATING TRANSMITTING AND APPLYING THE POWER SERVICES

Units for Combined Heating and Ventilating Service

A LINE of unit heaters suitable for combined heating and ventilating service, and in which either steam or hot water can be used, has been



Unit heater assembly

brought out by the Young Radiator Company, Racine, Wisconsin. The heating sections consist of flat vertical copper tubes, designed for maximum heat diffusion, to which are fused rows of flat copper fins, tapered slightly downward for additional strength and radiation. The tubes are brazed to the header plates.

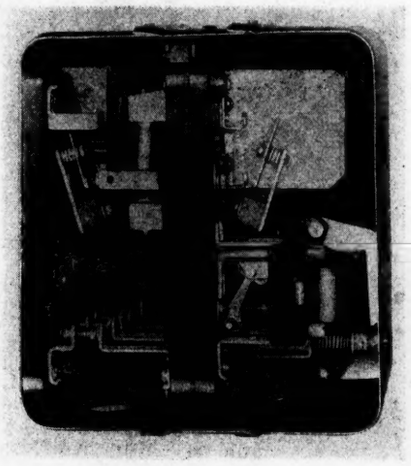
Air is circulated over the heating unit by means of a motor-driven fan, the largest unit having a $\frac{1}{6}$-hp. motor. A three-speed motor can also be furnished, the top speed being used for rapid increase of room temperature and lower speeds for normal operation.

Thermostatic control can be provided when desired. Adjustable deflectors are provided to direct the current of heated air downward or in any direction required. The units are comparatively light in weight, the largest weighing only 125 lb. and occupying a space of less than three cubic feet. Owing to this light weight they can be suspended directly from the steam mains without additional support.

New Switch Does Work of Three Devices

A NEW switch, designed to take the place of the magnetic switch, motor-circuit switch and inclosed fuses usually required in controlling the operation of a motor, is announced by the General Electric Company, Schenectady, N. Y. The switch can be applied to control any motor where a general-purpose magnetic switch would be used.

It consists of three sections: A back portion containing a motor-circuit switch, a middle portion containing a base on the front of which the magnetic switch is mounted and on the back of which clips are provided for fuses, and the front cover. The back portion is built for mounting directly on a wall. No flexible



Cross-section through the three parts of the switch

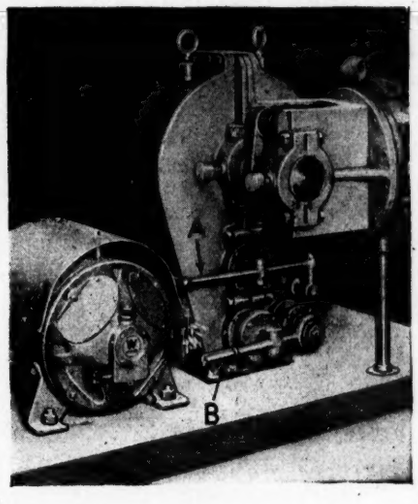
connections are used between the sections. As a result of this construction the switch mechanism may be easily and quickly removed from the mounting in case of trouble or for inspection purposes. At such a time the middle section of the switch is taken out and a spare section substituted. The switch is also designed to allow removal and substitution of spare mechanisms with safety to the operator. A guard over the incoming line terminal prevents accidental contact, and the switch cannot be removed from the back section unless the motor-circuit switch is open. Overload protection is provided by two temperature overload relays which are so designed that they will trip the contact mechanism just before the overload will cause the motor to be excessively heated.

The switch is furnished with a holding interlock which permits its use with a "Start-Stop," momentary-contact, push-button station. When such a push-button station is used, if the voltage fails the contactor will open and will not close automatically on return of the voltage, making it necessary to press the "Start" button.

Reduction Gear for Single-Retort Stokers

THE illustration shows a triple-reduction gear unit brought out by the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., for driving its single-retort stokers.

The unit comprises a combination of spur and helical gearing with tapered roller bearings and arranged for splash lubrication. It is fitted with a two-speed transmission, the



Two-speed reduction gear

speed change being made by the lever *A* on the side of the gear box. The clutch, which is of multiple-disk type, is operated by the lever *B*. With the driving motor running at 1,000 r.p.m. the gear box turns the stoker cranks 7 or 13 r.p.m., as desired.

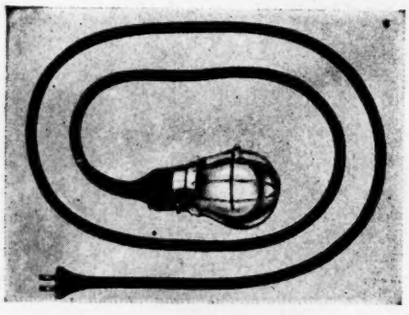
Fuse Pullers of Laminated Fiber

WITH a view to providing a ready means of renewing the various sizes of cartridge fuses with safety, the Ideal Commutator Dresser Company has brought out a full line of fuse pullers made of laminated fiber, as shown in the accompanying illustration.

Ideal fuse puller

The line includes four sizes: The "Midget" size, with three laminations and 5 in. long, for handling small fuses of ¼ to ½ in. in diameter; "Pocket" size, with five laminations and 7½ in. long for fuses from 0 to 200 amperes at 250 volts; "Giant" size, with seven laminations 12 in. long, for fuses from 100 to 600 amperes, 250 volts; and the "Jumbo" size, made with nine laminations 20 in. long, capable of handling fuses from 200 to 800 amperes at 250 volts or corresponding fuses of the 600-volt type.

In addition to handling the various sizes of cartridge fuses, the tool is adapted for adjusting loose cutout clips, handling laboratory test tubes and live electrical sparks.



"Unicord" extension lamp set

Rubber Sheathed Extension Lamp Set

THE extension lamp set illustrated is completely sheathed with soft rubber from terminal to terminal, thus making it liquid and moisture proof. The lamp socket is heavily protected yet is short and of a convenient size for getting into small places. The shell of the socket and the contact points are cadmium plated to prevent corrosion.

The set, which is put out by the Resilient Terminals Company, Oakland, Calif., is made in standard lengths of 20, 25 and 30 ft. Additional lengths can be secured extra.

Blowdown Valves for Pressures Up to 1,400 Pounds

THE illustrations show the tandem arrangement of blowoff valves put out by Yarnall-Waring Company, Philadelphia, Pa., for pressures up to 1,400 lb. and the improved planetary gear for use with the larger

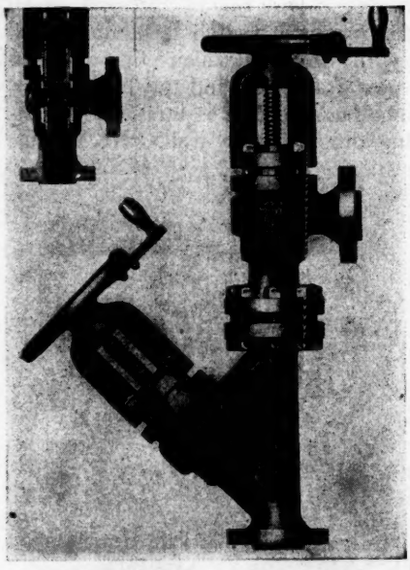


Fig. 1—Tandem arrangement of the type-C valve

valves on the high pressures. The essential features of the two valves shown are identical, the only difference in the two being the shape of the body. In the design of the lower valve the spindle is placed at a 45-deg. angle in order to facilitate operation.

The design of the Type C valve shown is essentially the same as that described in the May 24, 1927, issue. The one-piece plunger is extended to permit placing the lower ring of packing low down in the body, and the planetary gear train has been changed to include two sets of duplicate pinions in place of one, as formerly used.

Referring to Fig. 2, the gear *A* is held stationary by means of a pin into the valve bonnet, while the gear *B* is secured to the stem. The gears *C* and *D* of different diameters are carried on a common spindle mounted in the hub of the handwheel as shown.

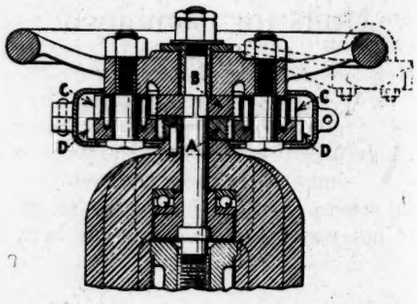


Fig. 2—Section of planetary gear used on high-pressure valves

This gear train serves to give a three-to-one ratio in the drive between the handwheel and valve spindle.

Small Vertical Motor

A LINE of small vertical motors, in which the interchangeability of various sizes on the same mounting base is an important feature, is announced by the Wagner Electric Corporation, 6400 Plymouth Ave., St. Louis, Mo.

The line includes the repulsion-induction, the split-phase, the squirrel-cage and direct-current motors. The alternating-current motors are built in 25- to 60-cycle models for operation at 1,200 to 3,600 r.p.m. The motor bearings are equipped with a labyrinth seal which prevents leakage of the lubricant into the motor winding and effects a dustproof and leakproof bearing housing.

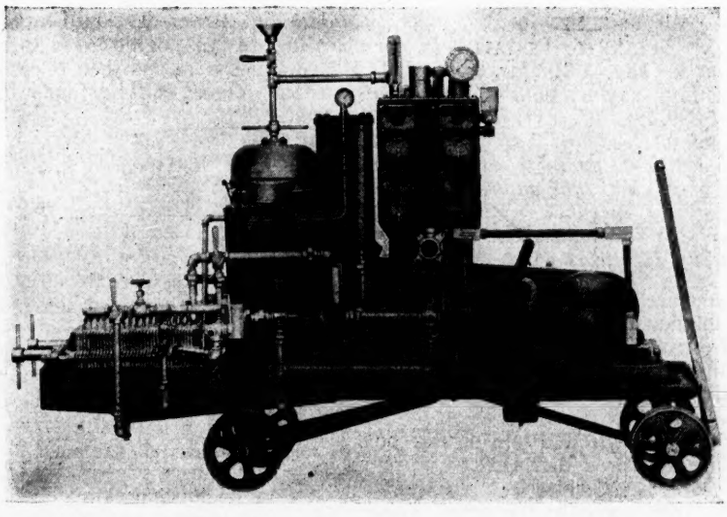
Vertical motor with cover

Non-Aërating Oil Purifier

COMPLETELY inclosed, non-aërating and fully automatic are the essential features of the new model F-50 purifier put out by the Hydroil Corporation, Lebanon, Ind. The machine has a capacity of 500 gallons an hour and the dimensions are: Length, 90 in.; width, 45 in.; height, 67 in. Its net weight is 1,450 pounds.

The oil in passing through the machine, does not come in contact with the air at any point. The feed cup and collecting pans are made integral and are fitted to the frame of the machine and to the suction tank with an airtight joint, and the incoming oil is piped to the top of the feed cup. The flow of oil to the bowl is measured and controlled by a modification of a Venturi meter working in conjunction with a pressure-regulating valve. A restriction or orifice is placed in the delivery pipe leading from the heater casing to the bowl, and the flow of oil is controlled by varying the pressure ahead of this orifice.

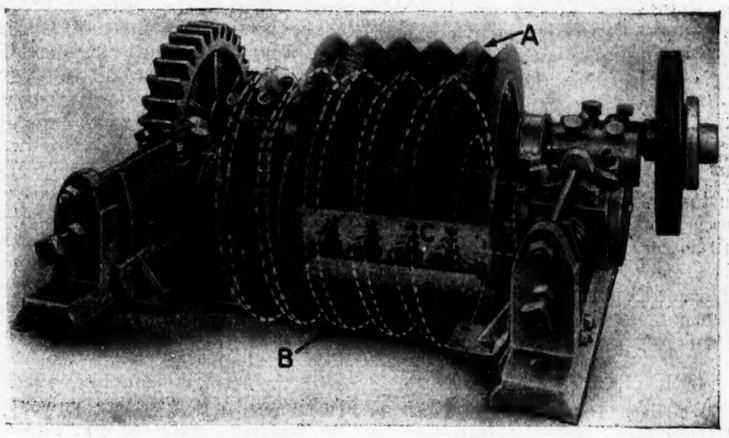
For maintaining the oil at the proper temperature the machine is equipped with three 8-kw. immersion-type heaters. These can be manually operated by standard quick-break switches, or if desired they can be controlled by means of double-pole contactors working on a standard push-button control. The operation of the contactors is either manual, by means of a push-button control, or automatic, by means of a suitable adjustable thermostat making and breaking contacts to cut in or out one or more of the heaters as may be necessary to maintain the correct temperature. The thermostat is so arranged that, should the flow of oil be interrupted or for any reason the oil or the heaters be overheated, it will automatically cut out all the heaters. The thermostat is adjustable and can be set for any range from 100 to 140 deg., each heater cutting out on a range of five degrees above or below the next heater in service. The filter on the new machine is identical with that furnished on the previous model F-50 in that it consists of two units or a total of 64 sections of standard 7x7-in. paper and operates under a normal pressure of 5 lb. All valves and switches are on one side of the machine for convenience of operation and the unit is fully equipped with ball bearings of the deep-groove type.



Purifier is fully automatic and totally inclosed

Coal Crusher Designed to Give Smaller and More Uniform Product

A NEW type of coal crusher designated the "Triplex" and designed especially to meet the increasing use of smaller and more uniform coal with stokers and pulverizers, is announced by the R. H. Beaumont Company, Philadelphia, Pa.



Two-roll crusher with breaker plate

The "Triplex," as the name implies, combines three crushers in one. It utilizes the two-roll crusher principle with a wedge-shaped breaker plate between the rolls. The rear roll *A* is shown in position, and the front roll is indicated by dotted lines, as at *B*.

The bearings of the roll *A* are held stationary, while those of the roll *B* are free to move a limited amount, the crushing pressure being adjustable by means of screws.

One of the important claims made for the new crusher is a capacity two or three times that of single- and double-roll crushers for the same size roll and peripheral speed. This increase in capacity is effected by providing two outlets instead of one and having the orifice zigzagged in such a way as to add about 40 per cent to its length.

The rolls have deep circular corrugations and the crushing action, after the primary crushing, is increased by the tearing action produced by the roll faces in passing the pyramid or wedge-shaped blocks on the breaker plate *C* below and between the rolls. In other respects, such as general design of frame, bearing construction, etc., the new crusher is essentially the same as the standard line manufactured by the company.

FROM AMONG THE READERS'

Conducted
By
L. H. Morrison

Torque of a Radial Steam Engine.—*In a steam engine design where six single-acting cylinders are set radially and steam is admitted in each cylinder for 60 deg. of the revolution, is the torque exactly uniform?* R. E. C.

No, the torque is not uniform, although the variation is much less than in case of an engine with a lesser number of cylinders. While steam at full boiler pressure exists in some one cylinder at all times, in the other cylinders the pressures have different values depending on the point in the expansion. The summation of all these pressures is not constant, and when the rod angularity is considered, the variation is greater. While a heavy flywheel is not needed, some flywheel effect must be incorporated in the design, say, by the crankpins or disks.

A Synthetic Ice.—*We are contemplating installing a skating rink in our town. The cost of installing coils in the floor and operating the necessary refrigerating plant seems too high for a rink that cannot expect any great income. We have been informed that there is a paint that when applied to a floor, makes the surface ice-like.* S. R. Co.

You are probably referring to a synthetic, so called, ice, sometimes known as "hypo." This is sodium thiosulphate mixed with water. It melts at about 120 deg. F. and, if floated on a floor at this temperature, will, upon cooling, form a hard glass-like surface that will bear skates without excessive cutting.

It is questionable if a commercial skating rink could use this substance, and before so doing, you are advised to experiment with a small section of flooring.

Thermal Efficiency of a Boiler.—*In order to settle a dispute in our engineering department, we wish to know if the term "thermal efficiency" may be correctly applied to the performance of a boiler.* J. B.

In engineering one should adhere to the common usage in the terms used when speaking of efficiency, etc. However, there is no reason why you cannot use, if you desire, the expression "thermal efficiency of the boiler." But it will be necessary to define what you mean by thermal efficiency, for in one case it might be taken as the ratio of the heat that the boiler has transmitted into the steam, divided by the total amount of heat in the furnace gases. Another man might mean the heat in the steam generated divided by the total heat in the combustible as fired, while still another might wish to use the ratio of the total heat in the steam divided by the total heat in the flue gases above the temperature of the steam in the boiler.

The American Society of Mechanical Engineers has several efficiencies in its boiler test code, one of which is the efficiency of the boiler, furnace and grate, which is the total heat in the steam generated divided by the total heat in the dry coal as fired. This is the term that ought to be used in connection with most boiler installations.

Thermal efficiency is more generally used in speaking of an engine and, of course, is the mechanical equivalent of the heat developed in the cylinder or developed at the shaft, divided by the total heat in the steam as supplied. Also, the term is sometimes used when dealing with a complete power plant; for instance, some of the later high-pressure power plants have a thermal efficiency of about 25 per cent, which is the heat equivalent of the energy delivered to the switchboard divided by the total heat in the coal as fired.

Consequently, the answer to your question would be that while people can use such terms as they desire, it is best always to use accepted terms and one ought not to use the term "thermal efficiency" when dealing with the performance of a boiler.

Size of Engine to Install.—*In our plant we have a 100-kw. and a 200-kw. uniflow engine, with a maximum load of 290 kw. We expect to add 200 kw. more of load and have decided to install additional engine capacity to the extent of 500 kw. The question at issue is, Shall we install a single 500-kw. or two 250-kw. units, the cost being practically identical?* C. C. G.

If you are operating two shifts and if a shutdown of part of the factory would involve a large loss, then two 250-kw. units are preferred, for you will then have ample power even if one engine fails.

On the other hand if you operate on only one shift or if the load can be reduced without a decided loss, the single 500-kw. unit would be the better solution. You could operate it at its best load and its steam rate would be better than that of a combination of two smaller units. By stocking those parts that are susceptible to damage, such as valves, crank and main bearings and valve gear, any ordinary defective part could be replaced after working hours.

However, it must be understood that in a situation like the one outlined, local conditions should always dictate the choice of equipment to be installed in the plant.

Using Air in Steam Engines.—*We have a steam hoisting engine with duplex cylinders size 10x12 in. Steam pressure is 125 lb. per sq.in., and at 200 r.p.m. the engine develops a maximum of 90 hp. We plan to use air at 125 lb. What would be the probable cubic feet of air that the engine would use?* A. G.

Without knowing the steam rate of the engine, to permit an estimate to be made of the clearance, effect of valve throttling, etc., an exact air consumption figure cannot be given. However, a fairly close approximation can be arrived at.

At 200 r.p.m. the horsepower output per pound of mean effective pressure of a 10x12-in. engine is 0.95 (see Low's "The Steam Engine Indicator.") Assuming 10 per cent clearance and a diagram factor, or a ratio of the real to the ideal-volume conditions, of 80 per cent, to develop 90 horsepower the cutoff must be approximately seven tenths.

The stroke volume of a 10x12-in. cylinder is 0.545 cu.ft., at 200 r.p.m., the volume displayed by the piston is 109 cu.ft. To reduce the air consumption the clearance should be reduced to 0.06. The volume of air at 125 lb. gage that would be admitted would be the cutoff volume plus clearance,

or $(\frac{7}{10} \times 109) + (\frac{1}{10} \times 109) = 82.8$ cu.ft.

The horsepower developed by air expanding in an engine to a pressure above atmosphere and then releasing at constant volume can be found by the formula.

$$Horsepower = \frac{144}{33000}\left(P_2V_2 + \frac{P_2V_2 - P_1V_1}{n-1} - P_aV_1\right)$$

in which

P_2 = initial pressure, lb. abs. = 140;
V_2 = volume of air taken into cylinder = 82.8 cu.ft.
P_1 = pressure at end of expansion;
V_1 = cu.ft. at end of expansion = piston displacement + clearance = 109 + 0.06 × 109) = 115.5 cu.ft.;
P_a = atmosphere pressure = 14.7 lb., or 15 lb. approximately;
n = expansion exponent for air = 1.4.

To find P_1 we have $P_1 = P_2\left(\frac{V_2}{V_1}\right)^{1.4}$

which makes $P_1 = 70$ lb. approximately.

Substituting these several values, we find the horsepower to be approximately 81. This does not take into account the effect of valve wiredrawing and early release, for which a deduction of 15 per cent must be made, making the net output 72 hp. It will be necessary to make the cutoff at about 0.8 stroke.

PROBLEMS

ANSWERS

from Our Readers

THE QUESTION

HOW can one calculate the efficiency of a superheater? C.B.C.

THE efficiency of any mechanical or electrical apparatus is always the ratio of the energy output to the energy, or heat, input. This applies to the superheater, but a difficulty presents itself in that all the quantities involved in the calculation of superheater efficiency are not definitely measurable, for the following reasons: On an integral superheater—that is, one placed in the setting of a boiler—the heat transfer will vary in accordance with the location of the superheater surface. For an integral superheating surface placed in the immediate zone of water-heating surfaces it is difficult to prorate mathematically with any degree of accuracy the heat units absorbed by the superheater and water-heating surfaces individually. This difficulty, of course, is not present in the separately fired superheater, where the heat absorbed by the steam in the superheater is equal to that given up by the products of combustion. Neglecting radiation losses, this relationship can be expressed as follows:

$$S.V.D. = W\,c\,(t_1 - t_2)$$

where S = sq.ft. of superheating surface:

V = mean coefficient of heat transmission per hour per degree difference in temperature;

D = mean temperature difference between the steam and hot gases;

W = weight of hot gases passing through the superheating surfaces in lb.;

c = mean specific heat of the hot gases (may be taken as .23);

t_1 = temperature of the gases entering the superheater F.;

t_2 = temperature of the gases leaving the superheater.

The coefficient of heat transfer varies in accordance with the location of the superheater. The following values of V may be taken as fairly representative: 1 to 3.5 for superheaters located at the end of heating surfaces; 3.5 to 6 for superheaters located between the first and second passes of water-tube boilers. In separately fired superheaters or superheaters located immediately over furnaces the coefficient of heat transfer may be taken as from 8 to 12.

The heat transfer from the products of combustion to the steam may also be expressed as follows:

$$S.V.D. = W\,C\,(t_g - t)$$

Where W = weight of steam passing through the superheater, lb.

c = mean specific heat of the superheated steam;

t_s = temperature of the superheated steam, deg. F.;

t = temperature of the saturated steam, deg. F.

For engineering purposes the mean temperature difference between the steam and gases D may be found as follows: The specific heat of superheater steam varies with the pressures employed, and for 100 to 150 deg. of superheat a value of 0.48 may be used.

It can be seen from the mathematical expressions that the quantities involved represent so many variables and immeasurable factors that superheater calculations at best would give unreliable results. E. A. BAERER.

Bayonne, N. J.

IN THE case of separately fired superheaters an efficiency may be calculated in the same way as for a steam boiler; namely, the ratio of the heat adsorbed by the superheater to the heat liberated by the fuel burned. The usual type of integral superheater is considered a part of the boiler installation, and "boiler efficiency" as calculated from boiler tests is the combined efficiency of boiler, furnace, grate and superheater.

The efficiency of the superheater alone might be expressed as the ratio of the heat added to the steam to that available in the gases passing the superheater. Thus:

$$E = \frac{W\,(H_s - H)}{W\,c\,(t_g - t_s)}$$

in which

E = efficiency of superheater;

W = steam through superheater;

H_s = total heat of superheated steam leaving superheater;

H = total heat of saturated steam entering superheater;

W = weight of gases passing superheater;

C = specific heat of gases;

t_g = temperature of gases at entrance to superheater;

t_s = temperature of superheated steam leaving superheater.

It must be remembered, however, that if the superheater is to be considered separately from the rest of the steam-generating installation, it becomes simply one type of heat-transfer apparatus and belongs in a general class with feed-water heaters, condensers, air heaters, oil coolers, etc. A calculated efficiency for any of these types of apparatus is of doubtful value.

A more important item is the mean coefficient of heat transmission. This, in the case of the superheater, is the average unit rate of heat flow through the walls of the superheater tubes and is expressed in B.t.u. per sq.ft. per deg. temperature difference per hour.

Rolla, Mo. P. A. WILLIS,
Asst. Prof. Mech. Engineering,
University of Missouri.

AS THE superheater, excluding the separately fired type, is essentially a part of the boiler, its efficiency, which should be the ratio of the heat absorbed to the heat in the gas, cannot be calculated. What the engineer should be interested in is the over-all boiler efficiency in terms of heat absorbed by the steam to the heat in the combustible. This should include the heat absorbed by the economizer, the superheater, the boiler and the water walls.

The employment of the term "superheater efficiency" is but one of many foolish terms that the would be engineer uses. J. R. MEGS.

Milwaukee, Wis.

A Question For Our Readers

WE are contemplating installing a 500-kw. uniflow engine plant to operate with 250-lb., 100 deg. superheat steam. The engines will not give more than enough exhaust to meet our process demands. What depreciation should we use in estimating probable operating costs?

E. L. C.

Suitable answers from readers will be paid for and published in the June 18 issue.

Events and Men in Power's Field

THE EDITORS WILL WELCOME THE CO-OPERATION OF READERS IN REPORTING INTERESTING HAPPENINGS, PERSONAL OR OTHERWISE

Oil and Gas Power Meeting at Penn State College June 24-27

Second National Meeting Promises Excellent Technical Program, Ample Time for Recreation and Exhibition of Oil Engine Parts and Accessories

FOR the second consecutive year the Oil and Gas Power Division of the American Society of Mechanical Engineers will hold its national meeting at State College, Pa., in conjunction with the Pennsylvania State College. In addition to a splendid technical program and entertainment, there will be an exhibition of oil-engine parts and accessories which should prove interesting to engine builders and users. The committee wishes it expressly understood that membership in the A.S.M.E. is not necessary for attendance at the meeting; everybody is welcome.

A glance at the list of technical papers to be presented will show what a well-rounded program is being provided. By limiting the number of papers at each session, however, there will be ample time for a full discussion. The sessions on Monday afternoon and evening will be devoted to high-speed oil engines with papers on such topics as, "High-Speed Oil Engine Design." "High-Speed Oil Engine Pumps and Injection Valves," "Combustion in High-Speed Oil Engines" and recent developments in the "Commercial Application of High-Speed Oil Engines."

For the session Tuesday morning there will be a paper of particular interest to Diesel users, on "Modern Refinements in Diesel Power Plants," in which the author will discuss the use of various accessories and auxiliaries, including automatic controls. Another subject of general interest is a summary of some of the results for the last year of the Penn State Fuel Oil Spray Research.

On Wednesday morning there will be papers on two subjects of wide appeal—"Marine Diesel Engine Operation" and "Diesel Engine Operating Costs." The latter subject, which is of special interest to all public utilities, will be covered in a report of the Costs Committee of the Oil and Gas Power Division based on an analysis of the replies received to a questionnaire sent out last fall. This will provide the first comprehensive data on the subject for Diesel engine installations in the United States.

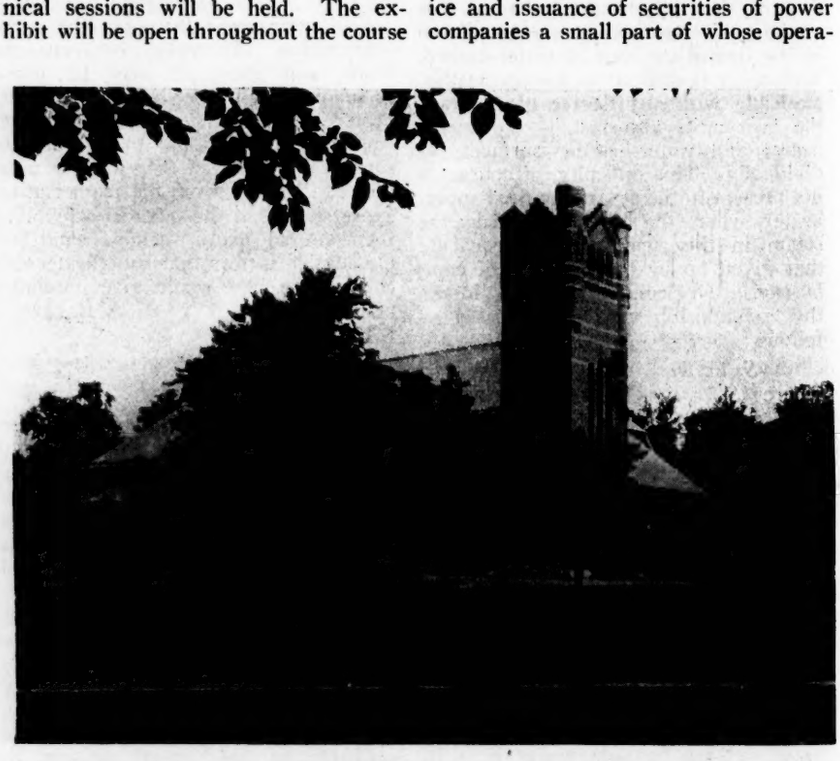
Last year the session on "Diesel Fuel-Oil Specifications" brought out an active discussion by the oil refiners, engine builders and engine users. As a result of the interest developed at that time, a special research committee on this subject was organized and has been actively at work endeavoring to draw up acceptable, standardized specifications which will be presented for discussion at the session on Thursday morning. At the same meeting the Technical Committee of the Diesel Engine Manufacturers Association will present a preliminary report on "Standardization of Diesel Engine Ratings," outlining the problem and indicating the difficulties to be overcome and the progress already made.

Some of the latest developments in the field will be shown at the exhibit of engine parts and accessories which is to be held in Penn State College Armory, directly across the street from Schwab Auditorium, where the technical sessions will be held. The exhibit will be open throughout the course of the meeting for the convenience of those attending.

A mountain excursion and picnic, a golf turnament, special drives through the surrounding country, the annual banquet and special entertainments for ladies are some of the features of an attractive recreational program.

Discussion of Power Problems at Annual Convention of Chamber of Commerce

Elimination of Section 14, relating to Governmental recapture of power sites, from the Federal Power Act, was proposed by General Charles Keller, of the Northern States Power Company, during the water-power and raw materials-conference at the seventeenth annual convention of the United States Chamber of Commerce in Washington, which convened April 30. General Keller declared that this section provides in effect for government operation of hydro-electric plants. He also criticised Sections 19 and 20 of the act. These sections should be repealed or modified because they permit the federal government to regulate the rates, service and issuance of securities of power companies a small part of whose opera-



PENNSYLVANIA State College Armory where the exhibition of Diesel engine parts and accessories will be held in connection with the second national meeting of the Oil and Gas Power Division of the A.S.M.E.

tions may come under the Power act.

A denial that the government is given unreasonable powers in the recapture of power site provision, was made by O. C. Merrill, Secretary of the Federal Power Commission. This provision merely enables the federal government to acquire the sites at the expiration of the periods of license, he said. Regarding the commission's supervisory powers over the issuance of securities, he stated that the only condition imposed on the power companies coming under the terms of the act, is that they give notice of their financing plans.

A resolution asking the National Chamber of Commerce to go on record as opposed to the proposal for leasing Muscle Shoals under such favorable terms that a particular company is given a subsidy, was presented by Charles J. Brand, executive secretary of the National Fertilizer Association. It was agreed that the resolution should be acted on later by the main body of the convention. In explaining the resolution, Mr. Brand expressed the opinion that it is as objectionable to private enterprise for the government to subsidize a particular unit of an industry as it is for the government to engage directly in business.

Hydro-electric development has become an obsolescent factor in power development as far as the government ownership advocates are concerned, it was stated by M. O. Leighton, consulting engineer and former member of the Water Resources Branch of the Geological Survey. Mr. Leighton explained that the small group agitating to get the government in the power business no longer has a weapon in the control of power sites, since the utilization of hydro-electric power has reached its zenith in most sections. He stated also that many power sites on streams that seemed promising twenty years ago are now known to be impracticable for efficient development because of the better methods that have come about in steam-plant operation. Because of these reasons, he believes that the public is beginning to get a rational view of the situation.

Output of Ford Power Plants Would Run Large City

The magnitude of the Ford Motor Company's factories in the Detroit area is indicated by the 1928 report on fuel consumption and power production.

Total fuel consumption at Power House Nos. 1 and 3 was 637,404 tons. This is approximately 12,700 carloads of coal, or a coal train reaching 100 miles.

The steam output of the power houses was 11,853,000,000 lb., an average of 2,000,000 lb. per hour. The kilowatt-hours output at the Rouge plant was 536,944,000 and at the Highland Park and Lincoln plants, 19,347,580, a total of 556,291,580 kw.-hr. This would be sufficient to provide lighting, power and street-railway transportation for a large metropolis.

*Spot * News*

PRESIDENT HOOVER *has accepted honorary chairmanship and will head the general committee for the international and national celebration of Light's Golden Jubilee, it was announced at a luncheon given by Paul D. Cravath at the Bankers' Club, New York, on April 30. The celebration commemorates the fiftieth anniversary of the perfection of the incandescent lamp by Thomas Alva Edison.*

* * *

BY A RECENT VOTE *of the Council of the Affiliated Technical Societies of Boston, the corporate name of that organization will be changed to the Engineering Societies of Boston.*

* * *

IMPROVEMENTS *to the amount of $350,000 are being made to the power plant of the Gulf Public Service Company at Jacksonville, Texas. They consist of the installation of a new steam turbine and boiler and a new brick building for the entire plant.*

* * *

GOVERNOR YOUNG, *of California, has formally advised the Secretary of the Interior and chairman of the Federal Oil Conservation Board, Ray Lyman Wilbur, of his willingness to co-operate with the Administration and the Board in plans for the conservation of the Nation's oil supply through interstate compacts for the control of drilling by the leading oil-producing States.*

* * *

THE MUNICIPAL ELECTRIC *light plant of Freeport, N. Y., has placed an order with the Busch-Sulzer Bros. Diesel Engine Company for a 1,500-hp. Diesel generator set. This will bring the plant's capacity to 5,700 hp., making it the largest Diesel station in the East.*

* * *

TRANSMISSION OF HEAT *from gases to colder solid masses is being studied quantitatively by the Bureau of Mines. Greater efficiency in industrial processes and furnaces is being sought in the inquiry.*

* * *

A 60,000-KW. STEAM *turbine unit has been ordered from the Allis-Chalmers Manufacturing Company by the Milwaukee Electric Railway & Light Company for installation in its Lakeside Power Station.*

* * *

SIR OLIVER LODGE *delivered the nineteenth annual May lecture before the Institute of Metals, London, England, on May 7. The title of the lecture, "Some Ideas About Metals," was sufficiently broad to enable Sir Oliver to give one of his characteristic and enlightening discourses.*

* * *

UNLESS IT IS FEASIBLE *to bring transmission lines 500 miles from plants in southern California, it will be necessary to build a steam power plant near Boulder Dam to supply power for construction purposes.*

Bureau of Standards Studies Lubricating Problems

Important differences have been found in the fundamental mechanical action of lubricants, depending upon the thickness of the oil film that can be maintained between the shaft and the bearing or other mechanical parts, M. D. Hersey, in charge of the work on friction and lubrication at the Bureau of Standards, stated recently. The full text of the statement follows:

The primary object of using a lubricant is to keep the bearing surfaces apart and the thickness of the film is therefore a matter of considerable interest. Thick-film lubrication is the most desirable and efficient type, but can be maintained only when the bearing surfaces are so designed as to permit the formation of a wedge-shaped film. This condition is realized in high-speed journal bearings and in Kingsbury thrust bearings. The performance of such bearings depends primarily on the viscosity of the lubricant.

When the surfaces are parallel or the speed very low and the loads per unit area very high, only extremely thin films can be maintained. The friction is greater for such films and depends on a property known as oiliness. In view of the importance of viscosity and oiliness, the Bureau is engaged in developing special methods for measuring these properties.

More About San Francisco High Pressure Plant

Two 52,500-kw. steam-electric generating units have been ordered from the General Electric Company by the Pacific Gas & Electric Company for installation in its steam plant, station A, at 23rd and Louisiana Sts., San Francisco. The station is being rebuilt and converted from 63,000 kw. generating capacity to 225,000 kw. This construction covers a five-year program, involving an expenditure in excess of $11,000,000.

Each of the new turbine-generator units consists of two elements, a high-pressure one developing approximately 15,000 kw. in electric energy and a low-pressure one developing approximately 37,500 kw. These four machines will generate at approximately 12,000 volts. The high-pressure element of each turbine will take steam at 1,200 lb. pressure and the low-pressure element will take steam at 400 lb. pressure. In both cases the temperature will be 750 deg. F. The 1,400 lb. pressure at which the boilers will operate is the highest yet applied on the Pacific Coast.

It is planned that the first unit of the rebuilt plant will be in operation early in the fall of 1930. The second unit will follow approximately six months later.

The new plant will be interconnected with the company's general distribution system and will be used to make up shortages in water power and to stand-by for emergency service in case lines go down or mountain plants fail.

Boiler Water Treatment a Feature of A.C.S. Meeting at Columbus

Symposium on Boiler Room Chemistry Given by Division of Industrial and Engineering Chemistry

A SYMPOSIUM on "Boiler Room Chemistry" was presented by the Division of Industrial and Engineering Chemistry of the American Chemical Society at its 77th meeting held April 29 to May 3, at Columbus, Ohio. Besides a general program, sixteen divisions held nearly fifty meetings, many of them simultaneous, and an extensive program of entertainment was provided for the large number attending.

Many of the papers presented during the day and a half devoted to boiler-room chemistry are of particular interest to power engineers. On Wednesday morning S. W. Parr opened the symposium with a few introductory remarks. Lincoln T. Work followed with a paper on "The Chemical Training Needed for Power Plant Work." Mr. Work said that the application of chemistry has become a real necessity in plants operating with boiler pressures of over 1,000 lb. According to him, the most significant chemical problems are properties of metals, treatment of boiler water, selection and processing of fuels, reactions in combustion, selection of lubricants and fusion reactions of ash and slags.

H. G. Turner presented a paper on "The Constitution and Nature of Pennsylvania Anthracite with Comparisons to Bituminous Coal," in which he exhibited photographs of the chief structural characteristics of anthracite and bituminous coals. He pointed out that oxidation is absent when anthracite is ground finely enough.

Typical results obtained with coal, semi-coke, beehive coke and activated charcoal particles were described by H. K. Griffin, J. R. Adams and D. F. Smith, in their paper on "The Rate of Burning of Individual Particles of Solid Fuels." Further combustion data were given in "The Determination of the Sulphur Content of Gases from Boiler Furnaces," by Edmund Taylor and H. F. Johnstone.

Nine papers related to the treatment of boiler waters were given, among which "Improved Equipment for the Treatment of Feed Water for Modern Steam Boilers," by Joseph D. Yoder, was particularly interesting. This paper directed attention to the importance of proper feed-water treatment for boilers operating at the modern high pressures of 400 to 1,200 lb. Illustrations and descriptions were given to show practical methods of treating water with phosphate to supplement the hot process lime and soda treatment and also deaëration. A recently developed sulphuric-acid feeding equipment was described for treating boiler-feed waters to give a proper relationship of sodium sulphate to sodium carbonate from the embrittlement point of view. Mr. Yoder drew the conclusion that the modern high-pressure, high-rating boilers can be operated with satisfaction if proper equipment is installed for the treatment of the boiler feed water.

Other papers on boiler waters were: "Laboratory Experiments with a Foaming Boiler Water," by A. S. Behrman, in which it was shown that the removal of organic coloring matter reduced foaming; "The Use of Tannin Extract for the Control of Corrosion in Steam Boilers," by A. H. Reynolds, who said that chestnut-oak extract is the most efficient for the removal of oxygen; "Zeolite-Deconcentrator Combination for Boiler Water Purification," by Elwood W. Scarritt, in which the results obtained with a combination system under boiler room conditions for a period of 200 days were shown by curves and tables; and "The Mechanism of Formation of Calcium Sulphate," by E. P. Partridge and A. H. White. Operating data on water conditioning were given in the two papers: "Chemical Proportioning of Internal Feed Water Treatment," by E. M. Partridge and "Some Examples and Precepts of Water Conditioning," by R. E. Hall.

In the Division of Petroleum Chemistry, meeting on Tuesday, an interesting paper on "The "Relation Between Physical Characteristics and Lubricating Values of Petroleum" was presented by E. D. Ries. He pointed out that the empirical tests now used for petroleum oils tell far from the whole story on performance. In Mr. Ries' opinion the tests to be retained are the carbon residue, viscosity and viscosity-temperature coefficient; and those to be changed or devised anew are the cold test, evaporation, "oilness" and resistance to oxidation.

The meeting was concluded on Friday, May 3, with many interesting trips to industrial plants at Dayton and other Ohio cities.

Future Plans Announced by St. Louis Company

Construction to cost upward of $75,000,000 will be inaugurated by the Union Electric Light & Power Company, of St. Louis, Mo., within the next three or four years, Louis H. Egan, president of the company announced April 30 in an address before the St. Louis Electrical Board of Trade. The proposed improvements are in addition to the $30,000,000 Osage River hydro-electric plant, which the Union electric company plans to start immediately.

In his address before the Electrical Board of Trade Mr. Egan told of the enormous growth of his company in recent years and of its expansion plans for the near future. Basing estimates on the experience of the last fifteen years or more, he said that two additional power plants the size of the present Cahokia plant south of East St. Louis, Ill., will be necessary within the next few years to supply the St. Louis district with electric energy.

The Union Electric Company and its subsidiaries serve a territory from Burlington, Ia., to Fredericktown, Mo., a distance of about 300 miles and 200 miles wide. In 1928 the company's output increased 18.6 per cent over 1927. It now operates the Keokuk dam plant and coal plants in St. Louis, Venice and Cahokia.

It is probable that one of the new plants will adjoin the present comparatively small plant in Venice, Ill., while another addition to Cahokia may be decided on. The Osage River plant, near Bagnell, probably will be completed within three years.

Export Figures for February Announced

Recent reports of the Department of Commerce show some interesting statistics on the number of prime movers and generating sets exported from the United State during the month of February, 1929. For instance, there were 35 stationary steam engines, with a value of $35,354, exported as compared with 7 mechanical-drive steam turbines, with a value of $25,950. Turbine-generator sets, however, were exported to the number of 34, with a value of $14,062. From this it is evident that the present demand in foreign countries is for small stationary engines and generator sets.

A total of 44,696 sq.ft. of heating surface of water-tube boilers, with a value of $104,572, was exported to all countries, including Hawaii. There is still a fair demand for direct-current generators, as evidenced by the exportation of 12, with a value of $32,859. In February 444 rectifiers, double-current and motor-generators, etc., with a value of $42,862, were exported.

Diesel and semi-Diesel engines fared well in the list of exports, with a total of 61. This figure includes shipments to Alaska and Hawaii and represents a value of $112,683.

Navy Tests Compounds for Treatment of Boiler Water

The Bureau of Engineering, Department of the Navy, is making a study of the prevention of corrosion and other forms of destructive deposits in ship boilers. In an order made public April 27, the Chief of the Bureau, Rear Admiral H. E. Yarnell, explained that "the Bureau must decline to approve the use of any compound other than Navy Standard."

The Bureau has recently received several requests from commanding officers for authority to employ reagents other than Navy Standard Boiler Compound for boiler-water treatment. Instances have also occurred where offi-

cers have applied directly to manufacturers and distributors of these various reagents for sufficient material to use in one or more boilers.

At the present time the Bureau is conducting tests, both in the laboratory and in service aboard specifically designated ships, of the several preparations and methods which have been offered as scale-forming preventives, scale removers, anti-corrosives, and anti-priming agents.

Results of tests to date indicate that many of these reagents satisfactorily perform the functions for which they are designed, but since their employment involves a modification in the control of alkalinity, which control has been found to be a very important consideration, the possibility exists of caustic embrittlement and corrosion of boiler parts and the disintegration of gaskets and packing.

Until this possibility has been eliminated and more data covering methods of employment are available, the Bureau must decline to approve the use for boiler-water treatment of any compound other than Navy Standard.

New Chicago Office for Units of the Union Carbide & Carbon Corporation

On May 1 the Chicago district and Central Division offices of various units of the Union Carbide & Carbon Corporation moved to the new forty-story Carbide & Carbon Building at Michigan Avenue and South Water Street, Chicago.

Units of the Union Carbide & Carbon Corporation which will make this new building their Chicago home are: The Linde Air Products Company, The Prest-O-Lite Company, Inc., Oxweld Acetylene Company, Oxweld Railroad Service Company, Union Carbide Sales Company, Carbide & Carbon Chemicals Corporation, National Carbon Company, Inc., Haynes Stellite Company, J. B. Colt Company and Acheson Graphite Company.

Among the many interesting features of the building itself, is an elevator system having such innovations as automatic stop, push button control, automatic leveling at all floor landings and automatic spacing of all cars in the shaft. This is the first time this complete system has been installed in Chicago.

Oxwelded piping has been used for a major part of the building's arteries. From boiler room to tower the steam lines, 2½ in. or more in diameter, have been oxwelded throughout. An 8-in. and a 10-in. steam line rise from the boiler room, two floors below the street, through a pipe shaft. The 10-in. riser supplies all the floors below the 23d by down-feed risers from a loop on this floor. The 8-in. riser ascends to the tower with branches at each floor level. At the completion of the job a test for leaks showed the welded construction 100 per cent perfect.

Coming Conventions

American Boiler Manufacturers Association. Annual meeting, June 3-5, Sky Top Lodge, Cresco, Pa. A. C. Baker, secretary, 801 Rockefeller Blvd., Cleveland, O.

American Institute of Electrical Engineers, annual summer convention, Swampscott, Mass., June 24-28. Pacific Coast Regional Meeting, Santa Monica, Calif. Sept. 3-6. F. L. Hutchinson, secretary, 33 West 39th St., New York City.

American Society of Heating and Ventilating Engineers, annual summer meeting, Bigwin Inn, Lake of Bays, Ontario, Can., June 26-28. A. V. Hutchinson, secretary, 29 W. 39th St., New York City.

American Society of Mechanical Engineers, spring meeting, Salt Lake City, Utah, July 1-4, 1929. Calvin Rice, secretary, 29 West 39th St., New York City.

American Society of Refrigerating Engineers. Summer convention at Penn State College, State College, Pa., June 20-22. Secretary, W. H. Ross, 35 Warren St., New York City.

American Society for Testing Materials. Annual meeting, June 24-28, at Chalfonte-Haddon Hall, Atlantic City, N. J. Secretary, C. L. Warwick, 1315 Spruce St., Philadelphia, Pa.

Association of Iron and Steel Electrical Engineers, 25th annual convention, Pittsburgh, Pa., June 17-22, 1929. A. A. Stewart, secretary, Pittsburgh Steel Co., Monnessen, Pa.

Canadian Electrical Association, annual convention, to be held June 19-21, at St. Andrews-by-the-Sea, N. B. H. M. Lyster, secretary, Power Building, Montreal, Que.

Master Boiler Makers Association, at Atlanta, Ga., May 21-24. H. D. Vought, secretary, 26 Cortlandt St., New York City.

National Association of Power Engineers, 47th annual convention, Chattanooga, Tenn., Sept. 9-13. Fred Raven, secretary, 417 South Dearborn St., Chicago, Ill. N. J. State Association annual meeting, June 1-2, at Eagles Hall, Elizabeth, N. J. Conn. State Association annual meeting, June 14-15, at the Stratfield Hotel, Bridgeport, Conn. New England States Association annual meeting, June 20-21, at Fitchburg, Mass.

National Board of Boiler and Pressure Vessel Inspectors. Annual meeting, June 18-20, at Detroit, Mich. Secretary, C. O. Myers, 14 Commercial Nat'l Bank Bldg., Columbus, Ohio.

National Electric Light Association. Annual meeting at Atlantic City, N. J., June 3-7. A. J. Marshall, secretary, 420 Lexington Ave., New York City.

National Exposition of Power and Mechanical Engineering. Grand Central Palace, New York City, Dec. 2-7. Charles F. Roth, manager, Grand Central Palace, New York City.

National Oil and Gas Power Meeting. Under auspices of A.S.M.E. Oil and Gas Power Division and the Pennsylvania State College. June 24-27, State College, Pa. F. G. Hechler, chairman, State College, Pa.

Northwest Electric Light and Power Association. 22nd Annual Convention, June 26-29, 1929, at Seattle, Wash. Registration and information: J. J. Hayes, Westinghouse Electric & Manufacturing Company, Seattle, Wash.

Universal Craftsmen Council of Engineers. Annual meeting in Detroit, Mich., Aug. 6-10, at the Book-Cadillac Hotel. Grand Secretary, T. H. Jones, 33 Linden Ave., Cherrydale, Va.

World Engineering Conference, Tokyo, Japan, October, 1929. All correspondence should be addressed to the Secretary, World Engineering Conference, Nikon, Kogyo Club, Morunouchi, Tokyo.

Sheffield, England, to Extend Power Plant

Orders to the value of £542,901 ($2,714,505) have been placed by the City of Sheffield, England, in connection with the extension of its municipal power station. Tenders were obtained for buildings, civil engineering works and a plant comprising one 25,000-kw. turbine-generator, three 120,000-lb. boilers and all accessories. It was made clear to the tenderers that the expenditure of money in Sheffield would be considered in their favor, and the result is that the successful concerns have undertaken to spend £200,000 ($1,000,000) in the city in labor and materials.

The Stirling Boiler Company obtained the order for the boilers and accessories to the value of £140,206 ($701,030), and in connection with this contract ten to twelve large hollow-forged boiler drums will be required. These are of the type—made from huge solid ingots—which has recently provided a new development in the boiler trade. Another big contract is that placed with the Mitchell Conveyor Company for building and civil engineering works at £172,893 ($864,465), while a third of £94,413 ($472,065) has been placed with the English Electric Company for the turbine-generator and condensing plant.

Power Development Active in South Africa

Electrical power development continues to advance with industrial progress throughout the Union of South Africa, Assistant Trade Commissioner Edward B. Lawson, Johannesburg, reports to the Department of Commerce.

The importance of ample supplies of electricity, especially for industrial undertakings, was recognized by the authorities several years ago, when the electricity act of 1922 was passed, and progress in the establishment of sources of electric power has increased as well as capacities of existing plants.

During the period 1925 to 1927 there was a consistent increase in the amount of electric current generated in the Union. In 1927 the total number of kilowatt-hours, both alternating and direct current, generated amounted to 1,695,800,000, which exceeded the amount for 1925 by almost 20 per cent.

The advances made in supplying power to users throughout the country have been reflected in the values of imports during the last few years. Commercial imports of electrical machinery have been substantial for several years and have maintained a fairly consistent upward movement, the total values for 1927, the latest available figures, having advanced considerably over those for the several years immediately preceding. Among the industrial purchasers the mines are a most important factor. During 1927 they bought electric generators and engines, hoists and motors valued at $374,522.

Obituary

E. E. Clark, chief mechanical engineer of the Republic Iron & Steel Company, at Bessemer, Ala., for more than 25 years, died on April 20 at the age of 62.

Thomas F. Quigly, superintendent of the Yuma Utilities Company and in charge of the Colorado River substation of the Southern Sierras Power Company, both subsidiaries of the Nevada-California Electric Corporation, Denver, Colo., died in Yuma, April 18.

Frederick H. Engelhard, senior member of the Hercules Float Works, Springfield, Mass., died on March 26. His brother, William A. Engelhard, will carry on the management of the business.

Personals

Alex Dow, president of the Detroit Edison Company, who recently returned from a tour of the Pacific Coast, sailed for Europe on May 8 with Mrs. Dow.

R. L. Boyer, of the C. & G. Cooper-Bessemer Company, who has been located at the Cooper works in St. Marys, Ohio, was transferred recently to the Bessemer works at Bessemer, Pa., where he will have charge of Diesel design.

Thornton Lewis, president of the American Society of Heating and Ventilating Engineers, will sail for England on the S.S. "Minnewaska" on July 6. He expects to spend two months in Great Britain and on the Continent.

Rudolph P. Miller, consulting engineer, New York City, has moved his offices to the Architects' Building, 101 Park Ave.

R. M. Sievers has been appointed district sales manager of the Harbison-Walker Refractories Company and makes his headquarters in St. Louis.

H. P. Reiber is now plant engineer of the Eaton Axle & Spring Company, Cleveland, Ohio. For thirteen years he was plant engineer for the Oil Well Supply Company, of Pittsburgh, Pa.

Business Notes

Leeds & Northrup has appointed Ernest E. Lee Company as exclusive representative for the L. & N. Metered Combustion Control apparatus in northern Illinois and Indiana, southern Wisconsin and the State of Iowa.

Fuller Lehigh Company has removed its New York office from 50 Church Street to 85 Liberty Street.

With the Society Sections

A. S. M. E. Anthracite — Lehigh Valley Section. Annual meeting May 16, with the Engineer's Club. Speaker: L. W. Wallace, secretary of the American Engineering Council.

A. S. M. E., Boston Section. Meeting May 15 at Engineers' Club. Subject: "Pulverized Fuel Systems," by Henry Kreisinger, research engineer, Combustion Engineering Corporation.

A.S.M.E., Textile Division. Meeting at the Lowell (Mass.) Textile School on May 17 with the Textile Section of the National Safety Council. There will be a round-table conference on problems in the textile industry.

American Engineering Council. Meeting May 24-25, at Washington, D. C., of Administrative Board.

American Water Works Association, Illinois Section. Meeting May 13-14 at the Clayton Hotel, Waukegan, Ill. Secretary, M. L. Enger, Professor of Mechanics and Hydraulics, University of Illinois, Urbana, Ill. Minnesota Section. Meeting with the Minnesota League of Municipalities, June 12-14, at Austin, Minn. Secretary, R. M. Finch, Wallace & Tiernan Company, 240 South Fourth St., Minneapolis, Minn. Pacific Northwest Section. Meeting May 15-16 at Spokane, Wash. Secretary, Kenneth Shibley, 1005 Securities Building, Seattle, Wash.

Plant Engineers Club of Boston. Meeting May 15 at the University Club. Subject: "Unit Installations for Burning Powdered Fuel."

The Amtorg Trading Corporation announces that M. G. Gurevitch, of the company, and representative of the Soviet Supreme Council in this country, has left for the Soviet Union for a visit of three to four months to survey the interests of the company there.

Cutler-Hammer, Inc., Milwaukee, has established a new warehouse at Cleveland, Ohio. The territory to be served by the new facilities will include the entire central sales district.

The Watts Regulator Company, manufacturer of steam specialties, Lawrence, Mass., has appointed Garrett Burgess, Inc., 5050 Joy Road, Detroit, C. C. Phelps, 11 Park Place, New York City, and Lord, Hawley & Hammel, Inc., Cambria Street, Philadelphia, as representatives in their respective districts.

The Philadelphia Gear Works will open a new branch office at the Farmers Bank Building, Pittsburgh, Pa., on May 1.

A. P. Green Fire Brick Company, of Mexico, Mo., has made several additions to its distributing organization handling the firebrick accessory products, "Sairset," air-setting mortar and "Quik-Pach," plastic firebrick. The J. H. Richards Fire Brick Company, Schofield Building, Cleveland, Ohio, and the W. H. Bixby Company, First National Bank Building, Omaha, Neb., will add this to their handling of the A. P. Green firebrick, and the Steam-Economies-Toledo Company, 3357 Blanchard St., Toledo, Ohio, will handle only the new products.

The General Refractories Company has recently appointed sales representatives in both Cuba and Central America. Woodward & Macmilland, Edificio Metropolitana, of Havana, are the agents for Cuba, Guatemala, British Honduras, Salvador, Nicaragua, Costa Rica, Panama, Trinidad Island and Jamaica.

Linear Packing & Rubber Company, of Philadelphia, by the purchase of its new rubber mill, has acquired facilities for the control of raw rubber needed, and equipment both for producing the rubber cements used in packing manufacture as well as molded rubber items for the oil industries.

Fuel Prices

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; mine run, except Pittsburgh gas slack:

Bituminous (Net Tons)	Market Quoting	Price per Ton
Navy Standard	New York	$2.00@$2.55
Kanawha	Columbus	1.25@1.45
Smokeless	Cincinnati	1.75@ 2.00
Smokeless	Chicago	1.85@ 2.25
S. E. Kentucky	Chicago	1.35@ 1.65
Steam	Pittsburgh	1.40@ 1.75
Gas Slack	Pittsburgh	1.00@ 1.10
Big Seam	Birmingham	1.25@ 1.50
Anthracite (Gross Tons)		
Buckwheat	New York	$2.60@$2.75
Barley	New York	1.35@ 1.50

FUEL OIL

New York—May 9, f.o.b. Bayonne, N. J., 28@34 deg., Baumé, industrial use, tank-car lots, 5c. per gal.; 36@40 deg., furnace, tank-car lots, 6.25c. per gal.

St. Louis—May 1, tank-car lots, f.o.b. St. Louis, 24@26 deg., $1.39566 per bbl. or 42 gal; 26@28 deg., $1.44566 per bbl.; 28@30 deg., $1.49566 per bbl; 30@32 deg., $1,54566 per bbl.; 32@36 deg., gas oil, 4.276c. per gal.; 38@40 deg., distillate, 5.498c.

Pittsburgh—Apr. 30, f.o.b. local refinery, 30@34 deg., fuel oil, 5c. per gal.; 36@40 deg., 5.5c. per gal.

Philadelphia—Apr. 30, 13@19 deg., $1.05@$1.10 per bbl. or 42 gal.; 22 deg. plus, $1.47@$1.53 per bbl.; 23@27 deg., $2.10@$2.16 per bbl.

Cincinnati—May 6, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 5c. per gal.; 26@30 deg., 5.25c. per gal.; 30@32 deg., 5.5c. per gal.

Chicago—May 4, tank-car lots, f.o.b., Oklahoma, freight to Chicago, 90c. per bbl. or 42 gal.; 22@26 deg., 65c. per bbl.; 26@30 deg., 75c. per bbl.; 30@32 deg., $1.20 per bbl.

Boston—May 6, tank-car lots, f.o.b. 12@14 deg. Baumé, 4.4c. per gal.; 28@32 deg., 5.55c. per gal.

Dallas—May 4, f.o.b. local refinery, 26@30 deg., $1.25 per bbl. or 42 gallons.

TRADE CATALOGS

HEATERS—The Worthington Pump & Machinery Corporation, of Harrison, N. J., has put out a new 12-page bulletin, No. 210 B-1 in stationary feedwater heaters, N series. Illustrations show the general design and specific details.

SEAMLESS TUBES AND PIPES—Babcock & Wilcox Tube Company, 85 Liberty St., New York City, has issued a 24-page bulletin, Form No. 522, on Enduro KA2 seamless tubes and pipes. The booklet is divided under such headings as embrittlement at high temperatures, tables of the corrosion resistance of Enduro KA2 and others. There are charts and interesting illustrations of failures from explained causes.

REGULATING DEVICES—The 1929 catalog, of Neilan, Schumacher & Company, Santa Fe Ave., Los Angeles, Cal., shows a full line of sensitive automatic control equipment for the oil and gas industry. It also includes the first set of accurate charts showing fully the capacities, flow curves and other engineering information compiled from laboratory tests.

WELDING RODS—"High Test Welding Rods," an 11-page booklet just issued by the Oxyweld Acetylene Company, 30 E. 42nd St., New York City, describes an improved welding rod for making stronger welds in steel. This publication is divided into two major divisions: "Reasons for Specifying High-Test Rod," and " How to Use This Rod to Best Advantage."

ROOTS PRODUCTS — Blowers, Acme Blowers, Gas Pumps and Acme Gas Pumps, Meters, Liquid Pumps, Vacuum Pumps and Engineering, are the headings under which the bulletins of the P. H. & F. M. Roots Company, of Connersville, Indiana, are grouped, in an attractive loose-leaf collection of all its publications.

HYDRAULIC PACKINGS AND PUMP CUPS—Hydraulic packings and pump cups are the subject of a new booklet, form No. A49, put out by Alexander Brothers, Inc., Philadelphia, Pa.

WATER WALLS — Information concerning the Riley-LaMont water wall is given in a booklet put out by the Riley Stoker Corporation, of Worcester, Mass. The booklet is bound in color, has sixteen pages, photographic illustrations, and seven copies of blueprints of installations.

TRANSFORMERS—An 80-page catalog has recently been issued by the Kuhlman Electric Company, Bay City, Mich. This catalog is known as bulletin *27* and gives information on the company's lines of power and distribution of transformers. Part of the publication is devoted to design and construction, the remainder comprising many tables of weights, dimensions, voltages, costs and other data required in the purchase and installation of transformers.

DIRECT-CURRENT MOTORS, Induction Frequency Converters, Centrifugal Compressors, Station Oil Circuit Breakers, Metal-Clad Switchgear and a new Magnetic Switch, are the subjects of bulletins GEA-517B, 750A, 588B, 926A, 966A, and 1106, respectively, published by the General Electric Company, Schenectady, N. Y.

SWITCHING EQUIPMENT—Oil Circuit-Breakers—Two leaflets have been issued by the Westinghouse Electric & Manufacturing Company, East Pittsburgh, on truck-type switchboards and switching equipment and on oil-circuit breakers, respectively. The first contains four pages, with illustrations and diagrams, and the second has eight pages, also illustrated.

RUBBER-MOUNTED MOTORS—Bulletin No. 163, issued by the Wagner Electric Corporation, St. Louis, Mo., concerns rubber-mounted motors, developed especially for applications requiring ultra-quiet performance.

FURNACES—The principles of the Stratton vertical-jet furnace for steam generation are explained and the advantages of it put forth in a 16-page publication by the Stratton Engineering Corporation, 341 Madison Ave., New York City. It is illustrated.

New Plant Construction

COMPILED BY THE MCGRAW-HILL BUSINESS NEWS DEPARTMENT, WHICH IS PREPARED TO FURNISH A MORE COMPLETE DAILY SERVICE TO THOSE WHO WISH IT

Ark., Huntsville—Arkansas Electric & Water Co., J. A. Harrington, Mgr., awarded contract for the construction of a 60 x 60 ft. power plant to P. B. Reed, Huntsville. Estimated cost $30,000.

Ark., Little Rock—State, c/o J. B. Higgins, Secy. of State, authorized election to vote $3,250,000 bonds for the construction of a hospital including steam heating system, etc.

Calif., Los Angeles—Central Funding Co., had preliminary plans prepared for a 12 story hotel including steam heating system, elevators, etc. at Vine St. and Hollywood Blvd. Estimated cost $2,000,000. L. L. Jones, 2404 West 17th St., is architect.

Calif., Los Angeles—A. T. Murray & E. C. Dingwell, are having preliminary plans prepared for a 12 story office building including steam heating system, elevators, etc. at 18th and Hill Sts. Estimated cost $500,000. R. Falkenrath, Jr., 611 Chamber of Commerce Bldg., is architect.

Calif., Modesto—Modesto Irrigation Dist., C. S. Abbott, Secy., will receive bids until May 27 for furnishing and installing Diesel generating plant.

Calif., San Diego—Dept. of Public Works, Sacramento, is having plans prepared for the construction of a group of college buildings including power house, etc., at State Teachers' College here. G. B. McDougall, c/o Dept. Public Works, is architect.

Calif., Santa Barbara — Cottage Hospital, awarded contract for a 4 story addition to hospital at Third and Bath Sts. to A. Mackellar, 112 East Sala Sta. Estimated cost $500,000. Steam heating system, etc. will be installed.

Calif., Talmadge—Dept. of Public Works, Sacramento, is having plans prepared for the construction of a group of hospital buildings including sub-station, etc., at State Hospital. G. B. McDougall, c/o Dept. of Public Works, Sacramento, is architect.

Conn., Mansfield—Mansfield Training School and Hospital, F. Salmon, Comptroller, plans the construction of a group of buildings including power plant. Estimated cost $370,000. Architect not selected.

Del., Middletown—A. Felix Du Pont, Kennett Park, Wilmington, will soon receive bids for a group of church buildings to include power house, etc. here. Estimated cost $1,000,000. A. H. Borckie, Philadelphia, Pa., is architect.

Ga., Savannah—Georgia Ice Co., 41 Harmon St., awarded contract for the construction of a 90 ton ice plant on Louisville Rd. to G. C. Ramson, 104 Brady St. Estimated cost $100,000.

Ill., Chicago — Four Hundred Thirty North Michigan Building Corp., c/o Loebl, Schlossman & Demuth, 608 North Michigan Ave., Archts., is having preliminary sketches made for a 14 story office building. Estimated cost $1,000,000.

Ill., Champaign—G. J. Gallavin, 617 East Green St., is having preliminary plans prepared for a 3 story apartment, theatre and stores building including steam heating system, etc., at 5th and Green Sts. Estimated cost $550,000. R. Levine & Co. Inc., 829 West 70th St., Chicago, Ill., are architects.

Ind., Indianapolis—Bd. of Trustees of Indiana State Teachers College, H. C. Benbridge, secy., will receive bids until May 20, for the construction of a new boiler house, etc.

Ind., Indianapolis—City Hospital, had plans prepared for the construction of a power plant at 960 Locke St. Estimated cost $516,000. R. F. Daggett, 922 Continental Bank Bldg., is architect.

Ind., Knightstown—Indiana Soldiers & Sailors Orphans Home, L. A. Cortner, Supt., plans the construction of a power house. Estimated cost $200,000. McGuire & Shook, 941 North Meridian St., Indianapolis, are engineers.

La., New Orleans—Mercy Hospital, awarded contract for the construction of a nurses home and boiler room at Annunciation and Thalia Sts. to L. F. Favrot, Louisiana Bldg.

Mass., Belmont—Dept., of Mental Diseases, State House, is having plans prepared for the construction of a refrigeration store house including equipment at W. E. Fernald State School, C. P. Hoyt, 8 Beacon St., Boston, is architect.

Mass., Boston—Edison Electric Illuminating Co., 39 Boylston St., plans the construction of an electric sub-station at Atlantic Ave. and Oliver St. Private plans.

Mass., Easthampton—Williston Academy, A. V. Galbraith, will receive bids until May 18 for the construction of a recreation building including power plant, etc. Estimated cost $200,000. J. H. MacNaughton, 77 State St., Boston, is architect.

Mass., Plymouth—Water Dept., awarded contract for the construction of a pumping station including equipment on Billington St. to D. D. Howland, Plymouth.

Mass., Provincetown—Provincetown Light & Power Co., H. F. McDonald, awarded contract for the construction of a power plant on State Rd., to Chase & Gilbert, Park Sq. Bldg., Boston. Estimated cost $40,000.

Mass., Somerville (Boston P. O.)—First National Stores, 5 Middlesex Ave., will soon award contract for the construction of a meat storehouse including refrigeration plant. Estimated cost $1,500,000. Monks & Johnson, 99 Chauncy St., Boston, are engineers.

Mass., Springfield—Sanitary Ice Corp., 62 Summer St., Boston, awarded contract for the

construction of an artificial ice plant on Westland Ave., to J. G. Roy & Sons Co., 21 Silver St.

Mich., Farmington—House of Providence, 2500 West Grand Blvd., Detroit, awarded contract for the construction of a group of buildings including power house, etc., here, to H. G. Christman Burke Co., Fisher Bldg., Detroit. Estimated cost $750,000.

Mich., Pontiac — Grand Truck Railroad Co., 400 East Jefferson St., Detroit, is having plans prepared for the construction of a round house, power house, etc. for railroad yard on Oakland Ave, here. Private plans.

Mont., Great Falls — Columbus Hospital, Sisters of Charity of Providence, awarded contract for the construction of a 6 story hospital at 1601-25 1st Ave. N. to C. O. Jarl, Great Falls and H. J. Hammill, Bozeman. Estimated cost $1,000,000. Steam heating system, etc. will be installed.

Mo., Galt—City voted $20,000 bonds for extensions and improvements to electric light plant. W. B. Rollins & Co., 339 Railway Exchange Bldg., Kansas City, are engineers.

Mo., Kansas City — Grand Realty Co., 718 Bryant Bldg., awarded contract for a 16 story office building to Fridstein & Co., 111 West Washington St., Chicago, Ill. Estimated cost $1,500,000.

Mo., Lee Summit—City plans the construction of an electric light plant. Estimated cost $100,000. W. B. Rollins & Co., 339 Railway Exchange Bldg., Kansas City, Mo., are engineers.

Mo., Monroe—City plans extensions and improvements to electric light plant including engine and generator. Estimated cost $30,000. W. B. Rollins & Co., 339 Railway Exchange Bldg., Kansas City, are engineers.

Mo., St. Louis — City College Development Corp., c/o City College of Law & Finance, Mid-City Bldg., will receive bids in early summer for a 27 story office building. Estimated cost $1,500,000 J. L. Bowling and I. Shank, Arcade Bldg., are architects.

Mo., St. Louis — Continental Life Insurance Co., 10th and Oliver Sts., will soon receive bids for the construction of a 20 story bank and office building at 3611-17 Oliver St. Estimated cost $1,500,000. W. B. Ittner, 911 Locust St., is architect.

Mo., St. Louis—Union Electric Light & Power Co., 315 West 12th Blvd., L. H. Eagan, Pres., announced that construction work to cost upwards of $73,000,000 will be inaugurated within the next three or four years.

N. J., Asbury Park — City will soon award contract for the construction of a central heating plant. Estimated cost $500,000. Warren & Wetmore, 16 East 47th St., New York., are architects.

N. J., Athenia (mail Clifton)—Public Service Electric & Gas Co., 80 Park Pl., Newark, will build an electric switching station to include two 20,000 kw. condensers on Van Houten Ave. Estimated cost $1,000,000. Public Service Production Co., 80 Park Pl., Newark, is architect.

N. J., Englewood Cliffs—Paterno Construction Co., 100 East 42nd St., New York, N. Y., is having preliminary plans prepared for three 5 story apartment buildings including steam heating system, etc. at Palisade Ave. and Bergen St. Estimated cost $1,000,000. Private plans.

N. J., Jersey City—Public Service Electric & Gas Co., 80 Park Pl., Newark, will build an electric switching station 1051-1065 Garfield Ave. Estimated cost $40,000. Public Service Production Co., 80 Park Pl., Newark, is architect.

N. J., Newark—Bd. of Commissioners, City Hall, will receive bids until May 11 for changing Bay Ave., pumping station from a steam plant to an electric plant. J. Costello, City Hall, is engineer.

N. J., Perth Amboy—White Ice & Supply Co., c/o W. Clifford, Jr., 1177 East Grand St., Elizabeth, Archt., awarded contract for the construction of a 95 x 115 ft. ice plant on Seaman St. here to Shore Construction Co., 94 Christie St., Newark. Estimated cost $50,000.

N. J., Trenton — First-Mechanics National Bank is having plans prepared for the construction of a bank and office building including steam heating system at South Warren and State Sts. Estimated cost $1,000,000. York & Sawyer, 100 East 42nd St., New York, N. Y., are architects. H. G. Bolcum, 10 East 47th St., New York, is engineer.

N. Y., New York — Majestic Hotel Co. awarded contract for the construction of a 45 story hotel at Central Park W., 71st to 72nd Sts., to Chanin Construction Co., Inc., 122 East 42nd St. Estimated cost approximately $16,000,000.

N. Y., New York—Park Ave. and 39th St. Corp., M. Shroder, Pres., awarded contract for the construction of a 40 story hotel at 101 East 39th St. to Shroder & Kopel, 420 Lexington Ave. Estimated cost $6,000,000.

O., Ashtabula—Cleveland Electric Illuminating Co., W. H. Hartman, Purch. Agt., Illuminating Bldg., Cleveland, is having plans prepared for the construction of a 250 x 325 ft. power plant, including three 50,000 kw. turbo generators, etc., here. Estimated cost $11,000,000. Private plans.

O., Cleveland—Cleveland Union Terminal Co., C. L. Bradley, Pres., Terminal Tower, is having plans prepared for an 18 story bank and office building including steam heating system, etc. at West Second St. and Prospect Ave Estimated cost $4,000,000. Graham, Anderson, Probst & White, Railway Exchange Bldg., Chicago, Ill., are architects and engineers. Midland Bank, Williamson Bldg., is lessee.

O., Dayton—B. F. Cheatham, Quartermaster General, Washington, D. C., will soon receive bids for the construction of a power house at Wright Field here. Estimated cost $300,000.

O., Dayton—Dayton Power & Light Co., 20 South Jefferson St., plans the construction of a steam heating plant at Longworth and Eaker Sts. Estimated cost $300,000. Private plans.

Okla., Oklahoma City — Montgomery Ward & Co., Chicago Ave. and Larrabee St., c/o D. A. Johnston, Skirvin Hotel, Oklahoma City, awarded contract for a 10 story office building at Main and Walker Sts. to Wells Bros Construction Co., 53 West Jackson Blvd., Chicago, Ill. Estimated cost $750,000. Steam heating system, etc. will be installed.

Pa., Coatesville—U. S. Veterans' Bureau, Arlington Bldg., Washington, D. C. will receive bids until June 21 for the construction of a group of buildings including boiler plant, refrigerating and ice making plant, etc., here.

Pa., Reading—Reading Hotel Corp., awarded contract for a 15 story hotel, etc., to Hunkin-Conkey Construction Co., Newman-Stern Bldg., Cleveland, O. Estimated cost $1,000,000.

Tenn., Erwin—C. H. Stoll & Associates, has been granted franchise to construct a hydro-electric plant on Nolchucky river. Estimated cost $750,000. H. K. Bell, Lexington, is hydraulic engineer. Work will be done under the supervision of J. A. Switzer, head of engineering department of University of Tennessee.

Tex., Abilene — H. O. Wooten, will receive bids latter part of May for a 16 story hotel and theatre building including steam heating and ventilation systems, boilers, elevators, etc. Estimated cost $500,000. D. S. Castle Co., 701 Alexander Bldg., is architect.

Wash., Olympia—Washington Irrigation & Development Co., Seattle, has made application for permit to divert 50,000 sec.ft. of water from Columbia River in Yakima and Grant Counties and construct a dam, 2,300 ft. long and 30 ft. high, first unit to develop 200,000 hp. Estimated total cost $41,242,000.

Wash., Seattle — Bureau of Yards & Docks, Navy Dept., Washington, D. C., plans completion of barracks to include power house, etc. at Naval Air Station here.

Ont., Orrilia—Town Council, plans extensions and improvements to sewage system including pumping station. Estimated cost $64,087. Gore, Nasmith & Storrie, Confederation Life Bldg., Toronto, are engineers.

Ont., Windsor—Catholic Diocese of London, M. F. Fallon, London, is receiving bids for the construction of a hospital and home including steam heating system, etc. at Cavanaugh Rd. Estimated cost $600,000. Pennington & Boyde, 1002 Security Bldg., Windsor, are architects.

Equipment Wanted

Air Compressor, Motors, etc. — Bureau of Yards & Docks, Navy Dept., Washington, D. C., will receive bids until May 22, for air compressor, motors, etc. at Bureau of Commandant, Naval Operating Base, Hampton Roads, Norfolk, Va.

Boiler, Generator Unit, etc.—Bd. of Trustees, Indiana University, J. W. Craven, Secy., Indianapolis, Ind., will receive bids until May 16, for a water tube boiler, stoker, steam turbine generator unit, coal and ash handling equipment, switchboard, etc. for proposed power plant extension.

Generator—M. Beatty, County Clk., Los Angeles, Calif., will receive bids until May 27 for furnishing and installing a 300 kw. engine generator set at Los Angeles General Hospital.

Motors, Switchboard, etc. — City of Benson, Minn., S. A. Berg, Clk., will receive bids until May 21, for furnishing and installing a nine panel switchboard with a.c. motors, etc. in connection with pole line and wiring system.

Motors, Switchboards, Etc—Sewerage & Water Board, G. G. Earl, Supt., New Orleans, La., will receive bids until May 31 for motors, switchboards and accessories for Drainage system.

Pumping Equipment—A. J. Sooria, Clk., Ontonagon, Mich., will receive bids until May 17 for electric power driven pumping equipment, etc., for proposed waterworks improvements. Estimated cost $30,000.

Pumping Equipment — City of Hollywood, Fla., C. E. Burgoon, Mgr., will receive bids until June 11, for pumping equipment, etc. for proposed waterworks improvements.

Pumping Unit — City of San Saba, Tex., pumping unit for proposed waterworks improvements. Estimated cost $75,000.

Pumps, etc. — Bd. of Trustees of Eastern State Penitentiary, Graterford, Pa., plans to purchase two motor driven centrifugal pumps.

Industrial Projects

Ala., North Birmingham (Sta. Birmingham) —Lamson & Sessions Co., G. Case, Pres., 1971 West 85th St., Cleveland, O., is having preliminary plans prepared for the construction of a 3 or 4 story factory for the manufacture of bolts, nuts, rivets, etc. here. Estimated cost $200,000. G. S. Rider Co., Century Bldg., Cleveland, is architect and engineer.

Calif., Los Angeles—CASKET FACTORY—West Coast Casket Co., 1495 East 4th St., is having plans prepared for a 1 story, 87 x 250 ft. factory on Hooper St. F. D. Harrington, H. W. Hellman Bldg., is architect.

Calif., San Francisco—WINDOW SHADE and LINOLEUM FACTORY—W Volker Co., 631 Howard St., is having plans prepared for a 5 story factory for the manufacture of window shades and linoleum on Howard st. Estimated cost $150,000. G. Kalham, 315 Montgomery St., is architect.

Calif., Santa Ana—GLASS FACTORY—Pittsburgh Plate Glass Co., Frick Bldg., Pittsburgh, Pa., plans the construction of a 400 x 2600 ft., factory here. Estimated cost $4,000,000.

Ga., Rockmart—TIRE and RUBBER FACTORY—Goodyear Tire & Rubber Co., 1144 East Market St., Akron, O., awarded contract for a 3 story, 150 x 750 ft. factory to include 120 x 250 ft. warehouse, 150 x 250 ft. weave shed, etc., here to A. K. Adams & Co., 542 Plum St., N. W., Atlanta, Ga. Estimated cost $750,000.

Ind., Indianapolis — ASSEMBLY PLANT — Marmon Motor Car Co., J. H. Hohannow, V. Pres., awarded contract for a 1 story assembly plant, to H. K. Ferguson Co., Hanna Bldg., Cleveland, O. Estimated cost $500,000.

Ia., Carroll — AIRPLANE FACTORY — Saul Aircraft Corp., c/o W. I. Saul, is having preliminary plans prepared for the construction of an airplane factory. Estimated cost $125,000.

Mich., Pontiac — AUTOMOBILE FACTORY ADDITION — Oakland Motor Car Co., awarded contract for a 1 story, 120 x 455 ft., addition to automobile factory, to H. G. Christman-Burke Co., Fisher Bldg., Detroit, Estimated cost $130,000.

Mich., Detroit — SCREW PRODUCTS FACTORY — Federal Screw Works, 3401 Martin Ave., is having plans prepared for a 1 story, 70 x 400 ft., factory on Martin Ave. Estimated cost $55,000. R. Finn, 415 Brainard St., is architect. Equipment will be required.

Mich., Detroit—AUTOMOBILE ACCESSORY FACTORY—Ternstedt Mfg. Co., 6307 West Fort St., awarded contract for a 2 story, 125 x 134 ft. factory for the manufacture of automobile accessories on Crawford St. to J. A. Utley, 700 Harper Ave. Estimated cost $40,000. Electric motors and miscellaneous machine shop equipment will be installed.

N. J., Newark—MOTOR CAR FACTORY—Packard Motor Car Co., Broadway and 61st St., New York, N. Y., is having plans prepared for a 3 story, 200 x 245 ft., factory at Central Ave. from 16th to 17th Sts. Estimated cost $300,000. A. Kahn, 1004 Marquette Bldg., Detroit, Mich., is architect.

O., Cleveland—FOOD TERMINAL BUILDING —New York Central R.R., St. Clair Ave. and West Third St., plans the construction of a 1 and 2 story food terminal building. Estimated cost $1,000,000. H. A. Baldwin, Big Four Bldg., Cincinnati, is chief engineer.

O., Euclid (Br. Cleveland)—BRASS and COPPER FACTORY and POWER PLANT—Chase Brass & Copper Co., F. S. Chase, Pres., 236 Grand St., Waterbury, Conn., awarded contract for a 1 story, 225 x 1,500 ft. factory and 100 x 150 ft. power plant here to Austin Co., 16112 Euclid Ave., Cleveland. Estimated cost $3,000,000.

O., Hartwell — TILE FACTORY — Cambridge Tile Mfg. Co., 10th and Woodburn Sts., Covington, Ky., awarded contract for a 1 story factory on Forest St. here, to Roos-Meyer-Hecht Co., Stanton St., Cincinnati, O. Estimated cost $1,000,000.

Okla., Sand Springs.—STEEL BARREL FACTORY—Wackman Welded Ware Co., 2412 South 7th Blvd., St. Louis Mo., awarded contract for a 1 story, 50 x 200 ft. steel barrel factory here to J. R. Former Construction Co., Ritz Bldg., Tulsa, Okla. Estimated cost $65,000.

Tenn., Memphis — CHEMICAL PLANT — Plough Chemical Co., 121 South Second St., is receiving bids for a 5 story plant. Estimated cost $1,000,000. Hanker & Cairns, 123 South Court Sts., are architects. Jackson & Moreland, 31 St. and Jones Ave., Boston, are engineers.

Man., Winnipeg—STRAWBOARD and PAPERBOARD MILL and BOILER PLANT—Hinde & Dauche Paper Co., 43 Hanna St., Toronto, plans the construction of a strawboard and paperboard mill including boiler plant, etc. here. Estimated cost $1,000,000. Private plans. Equipment including beaters, cookers, jordans, paper machines, calenders, etc. will be required.

PRICES - MATERIALS - SUPPLIES

Electrical prices on following page are to the power plant by jobbers in the larger buying centers east of the Mississippi. Elsewhere the prices will be modified by increased freight charges and by local conditions.

SINCE LAST MONTH

A DECLINE in rubber-covered copper wire was the only change which occurred during April, in prices of electrical supplies listed here. No. 14, solid, single braid, for instance, is down 50c., to $7.20 per 1,000 ft., f.o.b., New York. Among power-plant supplies, the principal price change of the month was a decline of 9c., to 61c., in highest grade babbitt metal; 9c., to 45c., for intermediate grades; and ¾c., to 12c. per lb., for No. 4. Structural rivets advanced 20c. per 100 lb., to $3.80, at Chicago; other steel items remain firm with demand active.

POWER-PLANT SUPPLIES

HOSE—Quotations at New York warehouses:

	Fire Protection	50-Ft. Lengths
Underwriters' 2½-in., coupled, single jacket		(net) 60c. per ft.
Common, 2½-in., cotton, rubber-lined	80c. per ft. list, less	50%

Air—Best grade

¾-in., per ft.	3-ply	$0.30	4 ply	$0.36

Steam—Discounts from List

First grade	40%	Second grade	45%	Third grade	50–10%

RUBBER BELTING—List price 6-in., 6 ply, $1.83 per lin.ft. The following discounts from list apply to rubber transmission belting:

Best grade	50%	Second grade	60%

LEATHER BELTING—List price, 24c. per lin.ft., per inch of width, for single ply, at New York warehouses:

Grade	Discount from list
Medium	30–10%
Heavy	30– 5%

RAWHIDE LACING—For cut, best grade, 30–5%; 2nd grade, 45–5%. For laces in sides, best, 57c. per sq.ft.; 2nd, 52c., net. Semi-tanned, cut, 30–5%.

PACKING—Prices per pound at New York warehouses:

Rubber and duck for low-pressure steam, ¼ in.	$0.90
Asbestos for high-pressure steam, ¼ in.	1.75
Duck and rubber for piston packing	.90
Flax, regular	1.15
Flax, waterproofed	1.70
Compressed asbestos sheet	.85
Wire insertion asbestos sheet	1.20
Rubber sheet	.45
Rubber sheet, wire insertion	.75
Rubber sheet, duck insertion	.55
Asbestos packing, twisted or braided and graphited, for valve stems and stuffing boxes	1.40
Asbestos wick, ½- and 1-lb. balls	.50

PIPE AND BOILER COVERING—Discounts from list at New York warehouses are as follows:

85% magnesia, high pressure		50%
Asbestos, air cell, for low-pressure heating and return lines	4-ply	70%
	3-ply	72%
	2-ply	74%

PORTLAND CEMENT—New York, $2.25 per bbl., without bags, delivered by truck to site of job. Bag charge, 40c. per bbl.

STRUCTURAL STEEL—New York delivered price, beams and channels, 3 to 15-in.; angles, 3 to 6-in., ¼-in. thick; tees, 3-in. and larger; and plates, ¼-in. thick and heavier; all $3.30 per 100 lb. in lots up to 3,999 lb.

COTTON WASTE—The following prices are in cents per lb., at warehouse:

	New York	Cleveland	Chicago
White	10.00@13.50	16.00	15.00
Colored	9.00@13.00	12.00	12.00

WIPING CLOTHS—Prices per pound in lots of about 600 lb., for washed white wipers, as follows:

Chicago (100 lb. bales)	$0.16
New York (100 lb. bales)	.16
Cleveland (per thousand)	38.00

LINSEED OIL—These prices are for raw oil in barrels, f.o.b., in 1 to 4 bbl. lots:

	New York	Cleveland	Chicago
Per pound	$0.109	$0.11	$0.113

WHITE AND RED LEAD—Per 100-lb. keg, base price, f.o.b., New York:

	Dry	In Oil
Red	$13.75	$15.25
White	13.75	13.75

RIVETS—The following quotations are allowed for fair-sized orders from warehouse:

Tank rivets, ½-in. diameter and smaller, list (Apr. 1, 1927) less 60% in full packages, for immediate delivery from warehouse stocks in New York and vicinity.

Structural rivets, round head, per 100 lb.:

New York	$4.50*
Chicago	3.80
Pittsburgh mill	3.10

*Price is for full packages; broken package lots, $6.00 net, delivered.

REFRACTORIES—Prices in car-loads, f.o.b., plant:

Chrome brick, eastern shipping points	per net ton	$45.00
Chrome cement, 40@50% Cr_2O_3, in bulk	per net ton	22@25
Chrome cement, 40@50% Cr_2O_3, in sacks	per net ton	26@29
Magnesite brick, 9-in. straights	per net ton	65.00
Magnesite brick, 9-in. arches, wedges and keys	per net ton	71.50
Magnesite brick, soaps and splits	per net ton	91.00
Silica brick, Mt. Union, Pa.	per M	43.00
Clay brick, 1st quality, 9 in. shapes, Pennsylvania	per M	43@46
Clay brick, 1st quality, 9 in. shapes, Ohio	per M	43@46
Clay brick, 1st quality, 9 in. shapes, Kentucky	per M	43@46
Clay brick, 1st quality, 9 in. shapes, Maryland	per M	43@46
Clay brick, 2nd quality, 9 in. shapes, Pennsylvania	per M	35@38
Clay brick, 2nd quality, 9 in. shapes, Ohio	per M	35@38
Clay brick, 2nd quality, 9 in. shapes, Kentucky	per M	35@38
Clay brick, 2nd quality, 9 in. shapes, Maryland	per M	35@38
Chrome ore crude, 40@50%	per net ton	18.00@22.50

BABBITT METAL—Delivered, New York, cents per lb.:

Genuine, highest grade	61.00
Commercial genuine, intermediate grade	45.00
Anti-friction metal, general service	31.50
No. 4 babbitt (f.o.b.)	12.00

COLD DRAWN STEEL—Shafting and screw stock, warehouse prices per 100 lb., base, are as follows:

	New York	Cleveland	Chicago
Round or hexagon	$3.50	$3.65	$3.60
Flat or square	4.00	4.15	4.10

BOILER FITTINGS—F.o.b. warehouse, Jersey City, N. J., discounts from list:

Copper ferrules	70%
Boiler flanges	65-5%
Boiler stay bolts	60%
Boiler patch bolts	20%
Boiler fitting-up bolts	45%
Pressed steel boiler lugs	10%

WROUGHT PIPE—The following basing discounts from list are for large mill lots at Pittsburgh mill:

BUTT WELD

Inches	Steel Black	Steel Galv.	Inches	Iron Black	Iron Galv.
1 to 3	62%	50½%	1 and 1¼	31%	15%

LAP WELD

2	55%	43½%	2	23%	9%
2½ to 6	59%	47½%	2½ to 3½	28%	13%
7 and 8	56%	43½%	4 to 6	30%	17%
9 and 10	54%	41½%	7 and 8	29%	16%
11 and 12	53%	40½%	9 to 12	26%	11%

BUTT WELD, EXTRA STRONG, PLAIN ENDS

1 to 1½	60%	49½%	1 to 2	34%	18%
2 and 3	61%	50½%			

LAP WELD, EXTRA STRONG, PLAIN ENDS

2	53%	42½%	2	29%	13%
2½ to 4	57%	46½%	2½ to 4	34%	20%
4½ to 6	56%	45½%	4½ to 6	33%	19%
7 and 8	52%	39½%	7 and 8	31%	17%
9 and 11	45%	32½%	9 to 12	21%	8%
11 and 12	44%	31½%			

BOILER TUBES—Following are net prices per 100 ft. at New York warehouses on tubes manufactured according to specifications of the American Society of Mechanical Engineers:

Size	Lapweld Steel	C. C. Iron	Seamless Steel
1			$17.07
1¼			19 20
1½		$38 00	17 92
1¾		28 50	20 48
2	$17 33	25 00	20 24
2¼	19 84	28 25	23 00
2½	21 60	34 00	26 03
3	25.50	42 50	27 04
3½	30.25	49 50	30 67
3¾	31 50	52 75	33 33
4	38.03	67.00	40.11

These prices are net, per 100 ft., based on stock lengths. If cut to special lengths, billing will be based on the entire stock lengths.

In addition to the above, standard cutting charges are as follows:

2 in. and smaller.. 5c. per cut. 3 in..... 9c. per cut.
2½ and 2½ in..... 6c. per cut. 3½ to 4 in.... 10c. per cut.

ELECTRICAL SUPPLIES

ARMORED CABLE—Price per 1,000 ft.—5 per cent. 10 days.

B. & S. Size	Two Cond. M Ft.	Three Cond. M Ft.	Two Cond. Lead M Ft.	Three Cond. Lead M Ft
No. 14 solid	$31.50 (net)	$45.00 (net)	$180.00	$220.00
No. 12 solid	136.00	180.00	225.00	275.00
No. 10 solid	185.00	235.00	275.00	325.00
No. 8 stranded	305.00	375.00	420.00	500.00
No. 6 stranded	440.00	530.00	615.00	.....

From the above lists discounts are:		Lead Covered
Less than coil lots	50%	30%
Coils to 1,000 ft	60%	35%
1,000 to 5,000 ft	65%	38%
5,000 ft. and over	67%	40%

CONDUIT—Price per 1,000 ft.; **ELBOWS AND COUPLINGS**, per 100 pieces, extra f.o.b. New York warehouse. Discount of 5 per cent. for payment in 10 days. Delivery charges, approximately 5 per cent. additional; 10,000 lbs. and over delivered free.

Size In.	Conduit Black Per M	Conduit Galvanized Per M	Elbows Black Per C	Elbows Galvanized Per C	Couplings Black Per C	Couplings Galvanized Per C
½	$56.50	$61.34	$7.76	$8.83	$4.52	$4.92
¾	72.07	78.63	10.21	11.63	6.46	7.03
1	103.31	113.00	15.10	17.21	8.39	9.13
1¼	139.77	152.88	20.51	23.07	11.78	12.75
1½	167.12	182.79	27.34	30.76	14.56	15.75
2	224.85	245.94	50 13	56.40	19.41	21.01
2½	355.50	388.85	82.03	92.28	27.73	30.01
3	464.88	508 50	218.74	246.10	41.59	45.01
3½	585.30	637.74	483.04	543.46	55.46	60.02
4	714 17	776.30	558.23	628.06	69.32	75.02

CONDUIT BODIES AND FITTINGS—Black or galvanized.

	Less than $10 list	$10 list to $100	$100 list and over
Standard package	10%	20%	28%
Less than standard package	5%	10%	20%

CUT-OUTS—Following are net prices, each, in standard-package quantities:

CUT-OUTS, PLUG, SOLID, NEUTRAL OR 2-FUSE

S. P. M. L.	$0.12	D. P. D. B.	$0.31
D. P. M. L.	.16	T. P. S. B.	.35
T. P. M. L.	.27	T. P. D. B.	.47
D. P. S. B.	.16		

CUT-OUTS, N. E. C. FUSE, SOLID, NEUTRAL OR 2-FUSE

	0-30 Amp.	31-60 Amp.	60-100 Amp.
D. P. M. L.	$0.27	$0.70	$1.75
T. P. M. L.	.40	1.00	2.30
D. P. S. B.	.35	.87	.....
T. P. S. B.	.67	1.50	.....
D. P. D. B.	.65	1.75	.....
T. P. D. B.	1.12	3.00	.....
T. P. to D. P. D. B.	.75	2.10	.....

FLEXIBLE CORD—Price per 1,000 ft. in coils of 250 ft.:

No. 18 cotton reinforced heavy	$21 50
No. 16 cotton reinforced heavy	25.00
No. 18 cotton reinforced light	15 50
No. 16 cotton reinforced light	22.00
No. 18 cotton Canvasite cord	17 00
No. 16 cotton Canvasite cord	27.00
No. 16 super service cord or similar (2 wire) in 1,000 ft	$70 80 / *76 70
No. 14 super service cord or similar (2 wire) in 1,000 ft	106.20 / *115.05

*Less than 1,000 ft.

NATIONAL ELECTRIC CODE FUSES, NON-REFILLABLE—

250-Volt	Std. Pkg.	List	600-Volt	Std. Pkg.	List
3-amp. to 30-amp.	100	$0.15	3-amp. to 30-amp.	100	$0.30
35-amp. to 60-amp.	100	.30	35-amp. to 60-amp.	100	.60
61-amp. to 100-amp.	50	.90	65-amp. to 100-amp.	50	1.50
101-amp. to 200-amp.	25	2.00	110-amp. to 200-amp.	25	2.50
201-amp. to 400-amp.	25	3.60	225-amp. to 400-amp.	25	5.50
401-amp. to 600-amp.	10	5.50	450-amp. to 600-amp.	10	8.00

Discount: Less than one-fifth standard package, 60%; one-fifth to standard package, 65%; standard package, 70%.

RENEWABLE FUSES—List price each:

Sizes	250-Volt List-Price	600-Volt List-Price	Std. Pkg. Quantity	Carton Quantity
1 to 30-amp	$0.50	$1.10	100	10
35 to 60-amp	1.00	1.25	100	10
65 to 100-amp	2.00	3.00	50	5
110 to 200-amp	4 00	5.00	25	5
225 to 400-amp	7.50	11.00	25	1
450 to 600-amp	11.00	16.00	10	1
REFILLS—				
1 to 30-amp	$0.03 ea.	$0.05	100	100
35 to 60-amp	05 ea.	.06	100	100
65 to 100-amp	10 ea.	.10	50	50
110 to 200-amp	15 ea.	.15	25	50
225 to 400-amp	30 ea.	.30	25	25
450 to 600-amp	.60 ea.	.60	10	10

Discount Without Contract—Fuses:	
Broken cartons	Net
Unbroken cartons	22%
Ten unbroken cartons	40%
Discount Without Contract—Renewals:	
Broken cartons	Net list
Unbroken cartons	22%
Ten unbroken cartons	40%
Discount With Contract—Fuses:	
Broken cartons	10%
Unbroken cartons	26%
Ten unbroken cartons	42%
Discount With Contract—Renewals:	
Broken cartons	Net list
Ten unbroken cartons	42%

Carton quantities may be combined to obtain maximum discounts.

FUSE PLUGS, MICA CAP—

0-30 ampere, standard package (500)	$2.80
0-30 ampere, less than standard package	3.10

LAMPS—Below are present quotations in less than standard package quantities on Mazda standard, A type bulbs:

100—130 Volt Watts	General Type	Price Each	200—260 Volt Watts	Special Type	Price Each
15	A 17	$0.20	25	A 19	$0.25
25	A 19	.20	50	A 21	.25
40	A 21	.20	100	A 23	.45
50	A 21	.20	....	....	....
60	A 21	.20	....	....	....
100	A 23	.35	....	....	....

Standard pkg. quantities are subject to discount of 10% from list. Annual contracts ranging from $75 to $300,000 net, allow a discount of 15 to 40% from list.

PLUGS, ATTACHMENT—

	Each
Porcelain, separable, attachment plug	$0.18
Composition, 2-piece, attachment plug	.27
Swivel attachment plug	.12
Small size, 2-piece plug, composition	.07

RUBBER-COVERED COPPER WIRE—Per 1000 ft. f. o. b. New York:

No.	Solid Single Braid	Solid Double Braid	Stranded, Double Braid	Solid Duplex
14	$7.20	$9.90	$12.30	$20.50
12	10.90	12.69	15.50	27.00
10	14.85	16.85	20.40	36.15
8	22.05	24.80	27.10	51.00
6	.....	.....	39.50	.....
4	.....	.....	57.00	.....
2	.....	.....	79.50	.....
1	.....	.....	107.00	.....
0	.....	.....	132.00	.....
00	.....	.....	158.00	.....
000	.....	.....	193.00	.....
0000	.....	.....	235.00	.....

SOCKETS, BRASS SHELL—Price each, net:

	½ In. or Pendant Cap Key	½ In. or Pendant Cap Keyless	½ In. or Pendant Cap Pull	¾ In. Cap Key	¾ In. Cap Keyless	¾ In. Cap Pull
Standard package	$0.12	$0.10	$0.16	$0.16½	$0.14	$0.20
Unbroken carton	.14	.12	.18	.18	.16	.21
Broken carton	.16	.14	.20	.20	.18	.24

WIRING SUPPLIES—

Friction tape, ¾ in., less than 100 lb., 31c. per lb.	100 lb. lots.... 29c. per lb.
Rubber tape, ¾ in., less than 100 lb., 33c. per lb.	100 lb. lots.... 31c. per lb.
Wire solder, less than 100 lb., 33c. per lb.	100 lb. lots.... 31c. per lb.
Soldering paste, 2 oz. cans	$1.10 doz.

ENCLOSED SWITCHES, KNIFE—Safety type, externally operated, 250 d.c or a.c., N.E.C.

TYPE "C" FUSED BOTTOM

Size, Amp.	Double Pole, Each	Three Pole, Each	Four Pole Each
30	$4.50	$6.00	$7.25
60	7.50	8.25	10.50
100	10.50	13.00	22.50
200	16.00	20.00	36.00

Discounts:	
Less than $25.00 list value	30%
$25 .00 to $50.00 list value	35%
$50.00 list value or over	40%